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SUMMARY OF RESEARCH ACTIVITIES 1976 - 1977.(U)  
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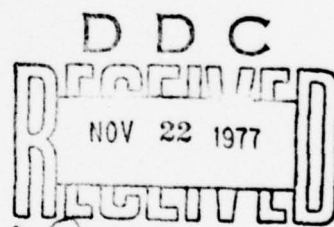
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SUMMARY  
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ACADEMIC DEPARTMENTS

1976-1977



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SUMMARY  
OF  
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1976 - 1977.

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10 BY

PROFESSOR WILSON L. HEFLIN  
ENGLISH DEPARTMENT

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## FOREWORD

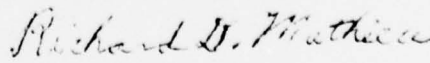
The academic excellence of an educational institution is measured by the achievements of its faculty in teaching, research, and related scholarly endeavors. It is the policy of the Naval Academy to provide and maintain an environment in which research activities that contribute to the professional growth of the faculty and outstanding midshipmen may flourish.

The research activities of the faculty range from very applied cooperative studies with the Navy research and development community to very fundamental investigations concerned with extending the frontiers of knowledge. The broad scope of research described in this annual report reflects the interests and expertise of the participating faculty and midshipmen, as well as the availability of laboratory, library and computer facilities.

This publication was compiled to acquaint the reader with faculty and midshipmen research efforts being done behind the classroom scene. Research results are published in manuscripts, reports, and prestigious journals as well as presented at important professional meetings and conferences. In addition to their teaching and research, the faculty contribute to their profession through participation in professional societies and consulting activities. This publication contains summaries of completed and on-going faculty projects, midshipmen research course projects including the Trident Scholar Program, and lists of presentations and publications. The work reported on was conducted during the period 1 July 1976 through 30 June 1977.

External support continues to increase significantly reaching a level of \$444,000 in Fiscal Year 1977 and \$895,000 in Fiscal Year 1978. This is undoubtedly due to the additional opportunities provided by new laboratories in the Engineering Studies Complex and the initiative of the well-qualified civilian and military members of the faculty. The increased interest and support by the Chief of Naval Research and the Chief of Naval Development continue to play a significant role and are gratefully acknowledged.

  
BRUCE M. DAVIDSON  
Academic Dean

  
RICHARD D. MATHIEU  
Director of Research

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**DIVISION OF  
ENGINEERING AND WEAPONS**



## AEROSPACE ENGINEERING DEPARTMENT

Commander Marle D. Hewett, USN, Chairman

The enclosed annual research summary for this Department reveals a deep interest by Department faculty over a very wide range of subjects. Nearly every member of the Department's twelve-man faculty is involved in gaining knowledge on some frontier from the thermodynamic cycle of a modified internal combustion engine to seeding effects on condensation of water vapor in aerodynamic nozzles. This intense research effort provides a rich atmosphere for learning and challenge. Consequently, the faculty is dynamic and up-to-date in their respective fields. As a result, the undergraduate instruction they provide is also up-to-date, interesting to the student, dynamic, and relevant.

Midshipmen are very actively involved in the research efforts of the Department. Through the Trident Scholar Program and research course work, they explore limited portions of a faculty member's larger research effort or take on small independent study. Research adds spice to the teaching environment and the rare excitement of discovery to those accepting the challenge.

This past year has been a particularly exciting one. Our Modified Internal Combustion Engine Project (NAHBE) pursued by Professor Pouring, Mr. Blaser, and others has matured and blossomed. The results of this research are receiving national recognition. Not only are military applications being aggressively pursued by Department of Defense agencies, but civilian applications are being pursued by the Commerce Department and the Environmental Protection Agency. Commercially, Ford Motor Company and Avco Lycoming Division are showing a great deal of curiosity and serious interest. There is a very strong possibility that the results of this research will affect the entire internal combustion engine market both militarily and commercially.

There are, of course, a number of other areas being actively pursued. A new major research project was begun this year, as Professor Carson designed and built a wing-in-ground-effect test facility and then proceeded to perform dynamic tests of the wing over a water surface. The work was supported by the Naval Ship Research and Development Center at Carderock, Maryland. Work was continued by NAVAIR Research Professor Gillerlain on Seeding Effects on Condensation, and by Research Professor Sladky on the Crypto-Steady Energy Exchange project. The Department supported over \$300,000 of funded research during Fiscal Years 1977 and 1978, which included two Trident Scholars, and six midshipmen research projects. It has been an active and exciting year in Aerospace Engineering.

\*\*\*\*\*

SPONSORED RESEARCH

AEROSPACE ENGINEERING DEPARTMENT

DEVELOPMENT OF COMPOSITE FLYWHEELS FOR ENERGY STORAGE AND GYROSCOPIC CONTROLS

Researcher: Assistant Professor William J. Bagaria

Sponsor: David W. Taylor Naval Ship Research and Development Center,  
Annapolis Laboratory

The technical objective of this project is to design, analyze, and test the most promising methods of construction for composite flywheels for energy storage and gyroscopic controls. The approach to the project is: (1) analysis of composite flywheels, (2) detailed design of the flywheels, (3) design of the test equipment, (4) construction of the flywheels and test equipment, and (5) evaluation and comparison tests of the flywheels.

\*\*\*\*\*

INVESTIGATIONS ON A TWO-DIMENSIONAL POWER-AUGMENTED RAM WING OPERATED STATICALLY OVER WATER

Researcher: Professor Bernard H. Carson

Sponsor: David W. Taylor Naval Ship Research and Development Center,  
Carderock Laboratory

This research concerns experimental observations made in connection with a larger comprehensive investigation, currently underway, aimed at the determination of the significant parameters governing the behavior of the power-augmented ram wing. In the present study, an attempt has been made to discover and to classify various phenomena having to do with this concept while in the static mode, in the presence of a free-water surface.

The power-augmented ram wing (PARW) is a wing designed to operate in ground effect, one whose lift is enhanced by using the airflow of a thruster to create a high-pressure region under the wing. Optimally, such a device should be designed to produce the maximum lift augmentation, in a variety of operating conditions, with the minimum sacrifice of propulsive thrust.

Experiments were performed in a rectangular tank, partially filled with water, and spanned by a flat-bottomed airfoil section, derived from a NACA 0015 thickness distribution. Upstream of the airfoil was placed a two-dimensional air jet, also spanning the tank. One side of the tank was transparent, to permit flow visualization. Two-dimensional turbulent jet theory was used to establish the relationship between the jet exit dynamic pressure and the pressure recovery under the wing, which was supported by experimental evidence. It was found that the recovery of pressure was not highly sensitive to jet geometry; however, the formation

#### SPONSORED RESEARCH

#### AEROSPACE ENGINEERING DEPARTMENT

of spray was. For minimum spray formation, a jet impingement angle of about  $25^\circ$  was established. Several interesting wind-wave flow instabilities were observed. A thrust-reversal phenomenon, predicted by inviscid theory, could not be duplicated in the present experiment.

\*\*\*\*\*

#### HIGH-ALTITUDE SIMULATION CHAMBER

Researcher: Research Professor Joseph D. Gillerlain, Jr.

Sponsor: Naval Air Systems Command

The objective of this project is to design a high-altitude simulation chamber for the aerodynamics laboratory in Rickover Hall. The facility will be used primarily for laboratory demonstrations and for midshipmen and faculty research projects. The chamber will simulate pressure, temperature, and humidity conditions for altitudes up to about 20,000 feet. Secondly, the facility will serve as a plenum chamber for a hypersonic wind tunnel.

The design is centered around a wind tunnel diffuser section. A vacuum pump system will produce the low pressures, and a recirculating refrigeration system will achieve the low temperatures for design altitude. A separate humidity control system will be included. Viewing and instrumentation ports will be provided for flow visualization experiments and for laser-optic flow diagnostic techniques.

Two contracts have been awarded, one for a refrigeration heat exchange system, and the other for the hookup of the high vacuum pumping system. A humidity system and instrumentation panel are yet to be specified. Further design work will continue through the summer, with the facility hopefully coming on line in late fall of 1977.

\*\*\*\*\*

#### INVESTIGATION OF SEEDING EFFECTS ON CONDENSATION

Researcher: Research Professor Joseph D. Gillerlain, Jr.

Sponsor: Naval Air Systems Command

The project continues the investigation of the effects of seeding on the condensation of water vapor in aerodynamic nozzles. The experiments are aimed at gaining further knowledge of the fundamental processes involved in heterogeneous nucleation, i.e., phase transition based on existing nuclei of different species, with respect to initial particle formation and subsequent growth rates. The results have important applications in such areas as hurricane seeding techniques and anti-fog devices for airports.

An existing chemical kinetics wind tunnel will be utilized. The condensation nuclei will be provided by chemical salts generated in the atmospheric inlet of the wind tunnel. Collected samples of these particles will be examined for size distributions using a scanning electron-microscope. Pressure distributions will be obtained by axial traverse of the wind tunnel test section. It is planned that a laser velocimeter will be utilized to obtain velocity profiles at different axial positions in the flow for comparisons with results calculated from the equations of fluid motion.

Preliminary seeding experiments using trimethylolethane (TME) seed were run in summer and fall of 1976. Results were inconclusive partly due to varying ambient conditions. The wind tunnel was disassembled in January 1977 and relocated in the Rickover Hall high-speed aerodynamics laboratory. As soon as the tunnel is operational, further tests are planned.

\*\*\*\*\*

#### MODIFIED INTERNAL COMBUSTION ENGINE PROJECT (NAHBE)

Researchers: Professor Andrew A. Pouring, Professor Bruce H. Rankin (Naval Systems Engineering Department), Assistant Professor Eugene L. Keating (Mechanical Engineering Department) and Richard F. Blaser (Contractor)

Sponsors: Naval Material Command (Code MAT-03Z), Naval Sea Systems Command (Code NAVSEA-0331), and Office of Naval Research (Code ONR-473)

The principal goal of this project is the refinement of and development of basic understanding of the new process of combustion in internal combustion engines with pressure exchange. The standard internal combustion engine piston is modified with a cap creating a secondary chamber. Modifications to carburetion, combined with this piston modification, result in engine operation on a new, more efficient thermodynamic cycle. A number of engines have been modified.

The engines to date have given up to 35 percent improvement in fuel economy at low rpm, extended the range of internal combustion engine operation from operation at no output to full output, greatly reduced exhaust emission, and have been operated on many fuels. Research is currently being expanded to diesel engines.

Interest in the project has been shown by a variety of governmental agencies and commercial industries.

\*\*\*\*\*



CRYPTO-STEADY THRUST AUGMENTATION

Researchers: Research Professor Joseph F. Sladky, Jr., Professor  
Andrew A. Pouring, and Professor Joseph V. Foa,  
George Washington University (Contractor)

Sponsor: Naval Sea Systems Command (Code NAVSEA 03512)

The objectives of the Crypto-Steady Energy Exchange (CSEE) project are to gain an in-depth insight and understanding into the fluid-fluid energy exchange by pressure forces, to identify and develop theory and experimentally verify the phenomena involved, and to develop performance maps and identify application scenarios for the CSEE principles.

Initially, an extensive review was conducted into the CSEE phenomena and associated problem areas such as fluid jet interactions, jet-jet interactions, jet stability problems, etc. Professor Foa has initiated efforts to develop a general model that will predict the performance of a number of thrust-generating systems and thus provide a comparative means for various propulsors.

This second year effort was devoted to the fabrication, testing, and instrumentation of a crypto-steady thrust augmentor. A range of test spinners was designed and fabricated at the Naval Research Laboratory.

The present activity focuses on the data reduction and display system. It is planned to utilize real time data reduction by the use of the PDP-15 computer and Xynetics plotter.

\*\*\*\*\*

AN INVESTIGATION OF POSSIBLE CORRELATIONS BETWEEN INDIVIDUAL PILOT PERFORMANCE AND NEUROLOGICAL FUNCTIONS

Researcher: Midshipman I/C Edgar Enochs

Advisers: Lieutenant Commander John A. Burt, USN, Professor Bruce Johnson (Naval Systems Engineering Department), and Associate Professor Karel Montor (Engineering and Technology Department)

Sponsor: Trident Scholar Program

The purpose of this study was to determine whether a meaningful correlation exists between some quantifiable element of a pilot's neurological activity and his performance at the controls of an aircraft with particular emphasis on degraded performance as a result

of "mental fatigue." The study represents the simultaneous development of two initially independent areas of investigation and their eventual integration for the purpose of correlation analysis.

Because the evaluation of pilot performance has traditionally been subjective in nature, a new and unique system for quantifying pilot performance was developed using the Singer GAT-1B Link Flight Simulator. A system was also developed for monitoring and recording pilot neurological functions in a cockpit environment.

Significant changes in pilot performance and neurological functions were observed as a result of sleep deprivation, holding all other factors as constant as possible. An apparent trend was observed relating changes in pilot performance to changes in a pilot's pre-flight neurological state described in terms of cross correlation and coherence function analysis of evoked potential tests. Ground work was laid for further investigation into the possibility of predicting pilot performance, based on a comparison of the pilot's current neurological state to a previously recorded baseline and developing neurologically-based criteria for pilot duty cycles.

\*\*\*\*\*

#### SINGLE-BLADED TORQUELESS HELICOPTER DESIGN

Researcher: Midshipman I/C Martinus M. Klijn

Adviser: Associate Professor Vadym V. Utgoff

Sponsor: Trident Scholar Program

A new type of helicopter was analyzed, designed, and constructed. The helicopter was of the backpack type and weighed about 50 pounds. It had a significantly lower rate of fuel consumption than other backpack helicopters or one-man lifts (such as the Bell Jetpack or the Army's Flying Platform). This helicopter will also autorotate automatically in the event of engine failure.

The design has a reciprocating engine which is placed counterpoise to a single rotor blade. The engine balances the rotor blade and drives a propeller. The thrust of the propeller provides the torque to drive the rotor. A new type of rotor head is proposed, in which the pitching moment due to the engine gyroscopic precession balances the pitching moment due to blade lift. This balance controls the blade pitch, thus providing automatic collective control and correcting for the asymmetry of lift in forward flight.

A working prototype was constructed.

\*\*\*\*\*



PERFORMANCE ANALYSIS OF A MODIFIED INTERNAL COMBUSTION ENGINE

Researcher: Midshipman 1/C Tim L. Whited

Adviser: Professor Andrew A. Pouring

Sponsor: Trident Scholar Program

The purpose of this project was to continue previous investigation into the various processes undergone in the combustion cycle of a modified internal combustion engine (NAHBE). The cycle is a combination of both the Otto and Diesel cycles, with added advantages not found in either of these two cycles. Recent laboratory results have indicated: (1) up to 25% reduction of fuel consumption, (2) reduction in peak operating pressures from 660 to 470 psi and temperature reduction from 5,500° to 4,000°F, (3) over 90% reduction in pollutants (carbon monoxide, hydrocarbons, and nitrogen oxides), (4) multifuel capability (low octane gasoline, fuel oil, alcohol and water, alcohol and charcoal), and (5) significant noise reduction.

In the NAHBE engine a pressure exchange cap is fitted on top of the piston to act as a balancing chamber. The pressure exchange between expansion and compression waves generated by this apparatus permits lower combustion temperatures and pressures, along with a decrease in pollutants emitted by the engine. It is the specific purpose of this project to verify that this pressure exchange process is actually occurring.

The cylindrical piston and cylinder were replaced with a rectangular piston and a cylinder was made from tempered glass. Transducers were used to measure pressure gradients between the combustion and balancing chambers. Optical analysis was used to visualize the expansion and compression waves.

\*\*\*\*\*

## RESEARCH COURSE PROJECTS

## AEROSPACE ENGINEERING DEPARTMENT

### AERODYNAMIC THROTTLING

Researcher: Midshipman 1/C Bruce A. Campbell

Adviser: Research Professor Joseph F. Sladky, Jr.

The purpose of this project was twofold. The first was to provide an opportunity for the student to develop an understanding of a facility with the Laser Doppler Velocimeter. The second was to investigate experimentally the flow field about a jet issuing at right angles to a free stream. The primary experimental variables were jet velocity, free stream velocity, jet mass rate, and jet orientation. The results have wide application in the aerospace field.

\*\*\*\*\*

### THRUST AUGMENTATION BY SECONDARY FLOW ENTRAINMENT

Researcher: Midshipman 1/C Scott A. Fontaine

Adviser: Associate Professor Vadym V. Utgoff

This project involved the design of an improved thrust augmentor for V/STOL applications. The first part of this project involved study of the prior art and a review of analyses of the process. In the second part a model wing was constructed and tested with an integral thrust augmentor.

\*\*\*\*\*

### WIND TUNNEL TEST OF SAILING CENTER

Researcher: Midshipman 1/C Jeffrey A. Gorman

Adviser: Professor Andrew A. Pouring

The Sailing Center roof is canted with a large overhang and because of this shape is subject to high loads during heavy winds. The purpose of this project was to design, fabricate, instrument, and test a scale model of the USNA Sailing Center. The model will be tested in the subsonic wind tunnel under hurricane wind conditions to determine air loads on the structure.

\*\*\*\*\*

## DESIGNING AND EQUIPPING A FULLY-INSTRUMENTED BD-5 AIRCRAFT PANEL

Researcher: Midshipman 2/C Kenneth Wallace

Adviser: Associate Professor Vadym V. Utgoff

The BD-5 aircraft is delivered without full IFR instrumentation. The purpose of this project was to design a fully IFR instrumentation package for the airplane to include: (1) panel design and cockpit arrangements, (2) properly spaced avionics and antennas, (3) electrical and vacuum requirements, and (4) weight and balance analysis.

\*\*\*\*\*

## PRESSURE RECOVERY DOWNSTREAM OF A LINEAR ARRAY OF CIRCULAR TURBULENT JETS

Researcher: Midshipman 1/C Mark A. Brynestad

Adviser: Professor Bernard H. Carson

This work was done as an extension of Carson's flow visualization studies of the power augmented ram wing and was aimed at determining expected velocity distributions and pressure recovery factors downstream of a linear array of circular jets, simulating a row of jet engines.

Considerable effort was expended in experimenting with different nozzle designs and baffling arrangements needed to produce uniform jets from a single plenum, and a near-optimum arrangement was finally developed. The actual pressure measurements intended to be conducted in this study were not performed, due to time limitations, and it is presently planned to complete this phase of the investigation during the fall semester, 1977.

\*\*\*\*\*

CARSON, Bernard H., Professor, "Experimental Observations of the Two-Dimensional Power-Augmented Ram Wing Operated Statically Over Water," David W. Taylor Naval Ship Research and Development Center, Report ASED 372, March 1977.

Experiments were performed in a rectangular tank, partially filled with water and spanned by a flat-bottomed airfoil section, derived from a NACA 0015 thickness distribution. Upstream of the airfoil was placed a two-dimensional air jet, also spanning the tank. One side of the tank was transparent, to permit flow visualization. Two dimensional turbulent jet theory was used to establish the relationship between the jet exit dynamic pressure and the pressure recovery under the wing, which was supported by experimental evidence. It was found that the recovery of pressure was not highly sensitive to jet geometry; however, the formation of spray was. For minimum spray formation, a jet impingement angle of about  $25^\circ$  was established. Several interesting wind-wave flow instabilities were observed. A thrust-reversal phenomenon, predicted by inviscid theory, could not be duplicated in the present experiment.

\*\*\*\*\*

CARSON, Bernard H., Professor, "The Theory of Lift for the Power Augmented Ram Wing," USNA Report, EW3-77, April 1977.

Based on a result from Actuator Disc Theory, which states that the dynamic pressure in the ultimate wake of a thruster operating in a free stream is just the free stream dynamic pressure increased by the disc loading of the thruster, a simple two-parameter model for the lift on a power augmented ram wing is put forth. One parameter is the aerodynamic lift coefficient, and the other is a pressure recovery coefficient, which is a measure of the amount of the thruster disc pressure recovered for lift augmentation.

Numerical values for these coefficients are developed for a particular configuration, which was tested under the auspices of the David W. Taylor Naval Ship Research and Development Center as part of a comprehensive experimental study. When these values are used to compute equilibrium altitudes for runs in which the model was free to heave, the results compared with observed values closely, with variations being of the order of a few percent.

\*\*\*\*\*

POURING, Andrew A., Professor, co-editor, Condensation in High Speed Flow. New York: American Society of Mechanical Engineers Symposium Volume, June 1977.

Expansion of low pressure steam in turbine stages, cloud chamber and expansion chamber processes, blowdown of a nuclear reactor, shock-tube-driver section expansions, supersonic and hypersonic nozzle flows, and rocket exhaust flows all have in common the basic physical process

of nucleation and growth of clusters. Since the early works of Stodola, Wilson, Yellott, Rettaliata, and others, many investigators have worked on furthering our understanding of the basic physical process responsible for the macroscopic phase change from the gaseous to the liquid/solid state.

New experimental techniques, new instrumentation, as well as the advent of the digital computer, have combined to allow greater freedom in modeling and analyzing both fluid dynamic as well as thermophysical properties of phase change.

This symposium deals with limited aspects of the wide range of condensing flows with both steady and non-steady flows considered. It is hoped that this compilation will serve as a focus for investigation of nucleation and condensation phenomena in high speed flows.

\*\*\*\*\*

POURING, Andrew A., Professor, Numerical/Laboratory Computer Methods in Fluid Mechanics. American Society of Mechanical Engineers, WAM Book No. G00106, 1976.

The growth of computer technology in the last two decades has made it possible to solve complex flow problems for which closed form analytical solutions simply do not exist. The application of computational methods to the problems of fluid mechanics has grown steadily during the past decade. This can be seen from the large growth of the number of journals.

The "Call for Papers" for this symposium was received with great enthusiasm. Because of the limitations of time and the number of sessions allowed in this meeting, only a limited number of papers could be selected. The high degree of interest in WAM 1976 and the contribution of many highly qualified technical papers presented at the symposium is evidence of the growing importance of computer methods in fluid mechanics. With the advent of the mini-computer and now the micro-computer, application of computers as laboratory instruments is becoming increasingly significant. Laboratory experiments that were impossible a few years ago are today's reality.

Twenty-four papers selected for the meeting were divided into the following five interrelated major areas of interest: (1) Navier Stokes Equations, (2) Boundary Layer Equations, (3) Heat Transfer and Boundary Value Problems, (4) Machinery and Transient Flow, and (5) Laboratory Methods. The papers of this conference review the current status of broadly selected areas of fluid mechanics.

\*\*\*\*\*



POURING, Andrew A., Professor, Richard L. BLASER (contractor), Eugene L. KEATING, Assistant Professor (Mechanical Engineering), and Bruce H. RANKIN, Professor (Naval Systems Engineering), "The Influence of Combustion with Pressure Exchange on the Performance of Heat Balanced Internal Combustion Engines," Society of Automotive Engineers Paper 770120, March 1977.

The heat balanced or combined cycle engine with time-dependent combustion sustained by two-chamber geometry is demonstrated experimentally. Evidence of time-dependent heat addition is given where combustion creates a field of pressure waves sustained by pressure exchange between two chambers.

The basic cycle and operating characteristics are reviewed and experimental results with CFR and glass-walled engines demonstrate the engine characteristic as compared to Otto engines. Improvements in thermal efficiency over the Otto engine in excess of 45% are demonstrated in some operating regimes. Considerable reduction in peak pressure and exhaust emission are also demonstrated.

\*\*\*\*\*

POURING, Andrew A., Professor, Richard F. BLASER (contractor), Eugene L. KEATING, Assistant Professor (Mechanical Engineering), and Bruce H. RANKIN, Professor (Naval Systems Engineering), "The Naval Academy Heat Balanced Engine (NAHBE)," USNA Report, EW-8-76, June 1976.

The heat balanced or combined cycle engine with time dependent combustion sustained by two chamber geometry is demonstrated experimentally. The theoretical basis and hardware for achieving the cycle are described. Evidence of time-dependent heat addition is given where combustion creates pressure waves sustained by pressure exchange between two chambers.

The basic cycle and operating characteristics are reviewed and experimental performance of CFR and glass-walled engines are compared to the Otto engine. Open-throttle and throttled engine results are given. Preliminary results are reported on parametric variation of engine variables and compression ignition behavior.

Improvements in thermal efficiency over the Otto engine in excess of 45% are demonstrated in some operating regimes. Considerable reduction in peak pressure and exhaust emission is also demonstrated.

\*\*\*\*\*



SLADKY, Joseph F., Jr., Research Professor, editor, Marine Propulsion.  
New York: The American Society of Mechanical Engineers, WAM Book  
No. G00110, 1976.

Thrust generation in a fluid medium--air or water--has normally been carried out through the transfer of mechanical energy from a rotor to the fluid, as in air and marine propellers. The thrust and efficiency of these systems depend on many factors and are each highest at a certain vehicle speed. In general the propulsion system of a particular vehicle must provide: sufficient thrust to achieve and maintain cruise speed, a high efficiency of thrust generation, and volume and weight in keeping with the vehicle configuration. In the case of the marine displacement vehicle and the low subsonic aircraft, these requirements are rather adequately satisfied by the propeller.

The advent of advance-concept, high-performance vehicles has brought about new, more demanding requirements on the prime mover, power transfer, and thrust generating systems. Various marine vehicles and ocean platforms are expected to operate at high speeds, in some cases approaching one hundred knots, at extreme depths, and under severe environmental conditions. Further complication may result from the unique configuration of some advanced-concept craft. The propulsion system may have to be integrated into confined spaces of limited accessibility and in every case the thrust generating element must be compatible with the external flow field of the vehicle. These and other factors generate propulsion system characteristics that are out of the realm of the subcavitating marine propeller and its steam plant prime mover.

The technical community has responded to these demands by developing an entire spectrum of thrust generating systems, power transfer mechanisms and prime movers. Both new concepts, as well as ideas that have existed for some time are being actively pursued. The development of appropriate theories and the attainment of an insight into a particular phenomenon has transposed concepts of laboratory interest into realistic propulsion alternatives.

This technology has its roots in diverse disciplines and hence the literature on the topic is scattered in various professional publications. In an attempt to combine and provide a perspective of advance marine propulsion systems this volume has been compiled. The contents do not attempt to cover all topics of marine propulsion nor to delve into the detailed specifics of a particular system but to present an overview and a summary of some current thinking and recent developments. It is hoped that this volume will further stimulate creative thinking in the marine propulsion field.

\*\*\*\*\*

PRESENTATIONS

AEROSPACE ENGINEERING DEPARTMENT

GILLERLAIN, Joseph D., Research Professor and Andrew A. POURING, Professor, "Effects of TME Seeding on Condensation in Nozzles." Paper read at Euromech Colloquium 88 on "Two-Phase Flow Systems with Condensation Phenomena," University of Karlsruhe, Karlsruhe, West Germany, 20 March-1 April 1977. (Abstract published in Colloquium Proceedings.)

\*\*\*\*\*

POURING, Andrew A., Professor, "The Heat of Reaction on Formation of an Aerosol." Paper read at ONR Contract Review and Nucleation Workshop, Chicago, Illinois, November 1976; also read at Euromech 88, University of Karlsruhe, West Germany, March 1977.

\*\*\*\*\*

POURING, Andrew A., Professor, "The Influence of Combustion with Pressure Exchange on the Performance of Heat Balanced Internal Combustion Engines." Paper read at SAE Congress and International Exhibit, Detroit, Michigan, March 1977; also read at NATO-ERDA Conference on Energy, Washington, D. C. , April 1977; and EPA Seminar on NAHBE Concepts, U.S. Naval Academy, Annapolis, Maryland, May 1977.

\*\*\*\*\*

SAARLAS, Mado, Associate Professor, "The Effect of Powerplant Component Failures and Various External Causes on Powerplant Reliability, Availability, and Capacity Factors." Paper read at ANS Executive Conference on Powerplant Reliability, Hot Springs, Virginia, 27-29 September 1976.

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## ELECTRICAL ENGINEERING DEPARTMENT

Professor Francis Joseph Eberhardt, Chairman

Research in the Department of Electrical Engineering has continued to mirror the revolutionary developments in solid-state electronics technology of the past decade. While a range of interests from thin-film technology to laser communications is encompassed, there has been a focus of attention on digital electronics. This in itself covers a broad spectrum of faculty and student interest, from sonar signal processing to computer interfacing, faster processing, and analysis.

The Department had six independent research projects within the Department, and two electrical engineering majors were involved in independent projects advised by other Departments. With the exception of metal deposition utilizing the high vacuum system, these projects are mostly concentrated in the digital/microprocessor applications course.

Research in the Department of Electrical Engineering serves three purposes: it supports continuing *development of the faculty*; it provides the important element of applied engineering for midshipmen who participate in the projects; and it contributes new knowledge to the disciplines. The second of these purposes is the most important at the Naval Academy. Research must provide the basis for a strong undergraduate program. Therefore, in addition to advancing the frontiers of their research areas, faculty members are committed to maintaining dynamic and challenging projects for midshipmen who choose to specialize in electrical engineering. Participating midshipmen have the opportunity to engage, with faculty, in unstructured scientific effort in wide variety. Thus, they are exposed to some of the techniques applied to the solution of practical engineering problems. Research activity provides midshipmen the opportunity to learn how the engineering community responds to the very-expanding needs of the service.

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THE EFFECTS OF TERMINAL DEPOSITION PRESSURE/TERMINAL DEPOSITION RATE RATIO (p/r RATIO) ON THE OPTICAL PROPERTIES AND REFLECTANCE OF ULTRA-PURE GOLD AND ALUMINUM FILMS

Researcher: Assistant Professor Jake H. Halford

Sponsor: Naval Academy Research Council

Reflectivity of aluminum thin films is a critical factor in high powered optical equipment. Vacuum deposition of controlled high reflectivity thin films has proven very difficult. Observed variations in optical properties have been attributed to uncontrolled surface and volume oxidation of the films. Monitoring of the terminal deposition rate ratio (p/r ratio) at the surface of the aluminum films has proved to be a useful tool in controlling optical properties.

Since aluminum films oxidize easily, this work has been extended to measure the terminal oxygen partial pressures and terminal deposition rates. This, it is hoped, will reduce oxide contamination, improve film reflectivity, and provide additional control of the optical properties.

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ANALYSIS AND SYNTHESIS OF LADDER NETWORKS

Researcher: Assistant Professor Tian-Siu Lim

Sponsor: Naval Academy Research Council

The analysis and synthesis of ladder networks have been investigated for a long time. However, little has appeared in the literature concerning the use of the chain parameter method in the design of these networks. The advantage of using chain matrix lies in the property that the chain matrix of a cascaded two-port network is the product of the chain matrices of the elements of the cascade. The method is easily suitable for digital computer solution.

This project consists of four parts, three of which have been completed. Part 1 of the project deals with proofs of two decomposition theorems for the synthesis of cascaded lossless ladder networks.

Using simple algorithms implemented by digital computer programs, this synthesis can be accomplished with ease and with little expenditure of time.

Part 2 of the project is concerned with the application of chain matrix decomposition techniques to the design of filters. Of particular interest are Butterworth, Chebyshev, and Bessel filters.

In Part 3, the decomposition property of the chain parameter matrix of the inhomogeneous ladder networks is investigated.

Part 4 is concerned with the optimal synthesis of double-terminated ladder networks. From a given transfer function with simple poles on the negative real axis a ladder network is to be realized with specified resistive terminations. It is hoped to show a realization which minimizes values of components.

The main application of the chain matrix decomposition method of synthesis is in the design of filters which are among the most important electronic components in any communication system in the Navy.

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#### SYNTHESIS OF WAVEFORMS USING A MICROCOMPUTER

Researcher: Research Professor Richard L. Martin

Sponsor: Naval Electronics Systems Command

The undergraduate electrical engineering laboratories at the U.S. Naval Academy are based around a central signal facility which provides the electronic signals and waveforms required for a particular experiment. These signals are distributed simultaneously to up to approximately 100 laboratory stations. During the past decade, frequency response experiments have utilized a mechanical stepper which has sequentially provided up to 12 signals from fixed generators. The purpose of this project was to develop a microcomputer-based system to replace the mechanical stepper.

Two systems were developed using a microcomputer for generating patterns of signals for use in frequency response and other experiments. The first system uses only the microcomputer and a digital-to-analog converter to directly generate low frequency (less than 1 KHz for sine waves) periodic waveforms of arbitrary shape. More complex waveforms are limited to lower frequencies. The second system uses a voltage-controlled oscillator, which is modulated by the microcomputer to provide higher frequency sinusoids. This system is ideally suited for narrow-based experiments where the ability to provide small increments in frequency around a particular center frequency is required.

The microcomputer is based on an Intel 8080A microprocessor, and the programs are written in machine language. The programs are written to accept a wide variety of data to allow flexibility in the choice of frequencies, waveshapes, length of time for each frequency, and the number of frequencies' output before the pattern is repeated.

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SPONSORED RESEARCH

ELECTRICAL ENGINEERING DEPARTMENT

MICROPROCESSOR LAB DEVELOPMENT

Researcher: Professor Ralph P. Santoro

Sponsor: Naval Electronics Systems Command

The hardware and software have been developed for programming of EPROMs (Erasable Programmable Read-Only Memory). The manufacturer's programming board was interfaced in a general way, so that EPROMs can be written from either the MMD-1 microprocessor unit, the PDP-8/E mini-computer, or an existing EPROM can be copied.

Development continues on software and hardware for effective inclusion of microprocessor control into the Central Signal Distribution System and course development for the logic track.

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## THE ABSORPTION OF SOUND BY PINE TREES

Researcher: Associate Professor Stephen H. Burns

The past year has been devoted to the theory of reverberation chambers with minimum wall losses in which to test pine boughs. The walls of such a chamber have infinite mechanical impedance and infinite heat capacity. The dominant losses in this chamber occur in the fluid closest to the walls. (The dominant losses in ordinary finite impedance walls occur in the walls themselves.)

A comparison has been made of the normal mode analysis of a parallelepiped with infinite impedance walls. The latter case was studied by P. M. Morse and is discussed in his classic book Vibration and Sound, McGraw-Hill, 1936. The total losses are, of course, less, and the viscous dissipation is a more complicated function of the mode numbers. The average (over all angles of incidence) absorption coefficient of the walls reflects both of these changes. Furthermore, it has been shown that the normal mode theory with infinite impedance walls is term-by-term equivalent to the Kirchhoff tube theory.

A manuscript has been submitted to the Journal of the Acoustical Society of America. Experiments are planned to examine the losses in a real chamber and to obtain data on real pine boughs.

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## HIGHER ORDER FILTERS USING ACTIVE, HEIZER-TYPE RC NETWORKS

Researcher: Associate Professor Charles A. Fowler, III

The purpose of this research is to develop the theoretical basis for higher-order electric filters, using an active element in conjunction with a Heizer-type distributed RC network.

One goal has been to determine the location of poles and zeros of the transfer function of the filter, and also to specify this information in terms of coefficient of polynomials that can be realized. This goal includes developing new topologies to realize band-pass and high-pass filters. Another goal is to produce tables of parameters from which a user can easily extract all necessary design information. Additional goals are to investigate the stability of these filters and their sensitivity to changes in parameters.

A topology to produce a band-pass filter has been developed. Tables of parameters for low pass filters of the Butterworth, Bessel, or Tchebyscheff types have been produced for filters of second order through ninth. Topologies to realize high-pass filters are being investigated as are the problems of stability and sensitivity.

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BISTABLE SWITCHING OF AMORPHOUS BISMUTH TRIOXIDE THIN-FILM DEVICES

Researcher: Midshipman 1/C Michael Magnotti

Adviser: Assistant Professor Jake H. Halford

Bistable switching has been observed in Au-Bi<sub>2</sub>O<sub>3</sub>-Au thin-film devices. The devices exhibited a large resistance ratio between ON states (conducting states) and OFF states (non-conducting states). A study of the polymorphs of Bi<sub>2</sub>O<sub>3</sub> revealed that amorphous and crystalline forms exist at room temperature. Attempts to produce pure amorphous films resulted in allotropic films having good switching characteristics. Attempts are now being made to measure switching times. Amorphous switching devices have potential in adaptive logic applications and non-volatile memory applications.

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MINICOMPUTER-CONTROLLED AUDIO AMPLIFIER TESTING SYSTEM

Researcher: Midshipman 1/C John J. Polcari

Adviser: Professor Ralph P. Santoro

The measurement of gain magnitude and phase in audio amplifier equipment is very time-consuming and repetitive. Because it is also a very common measurement, it was considered one that was a prime candidate for automation.

This project centered around the design of a minicomputer-based testing system that automatically measures the gain magnitude and phase of an audio amplifier over the frequency range from 5Hz to 20KHz. The final design employed a PDP-8E minicomputer as the controller at the test site and the Honeywell-635 computer as the data processing and storage site. The 8E minicomputer oversees the generation of test signals and the collection of raw response data at the test site. A communication link allows transfer of the collected data to the 635 for processing and storage. The processed data can be returned to the test site for display upon command from the 8E.

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## THE DESIGN AND CONSTRUCTION OF A DIGITAL DIFFERENTIAL ANALYZER

Researcher: Midshipman 1/C Duane H. Wilson

Adviser: Research Professor Richard L. Martin

The purpose of the project was to investigate the possibility of constructing a digital differential analyzer (DDA) using standard TTL hardware. The DDA is a device which was conceived when large digital machines were first constructed and has not received much attention recently. The DDA acts as an integrator (or a multiplier) by accumulating increments of an input variable and producing increments of an output variable. In effect, the DDA provides an output whose pulse repetition frequency (PRF) is proportional to the PRF of an input, the constant of proportionality being determined by the contents of another register.

Using standard TTL hardware, a 4-bit and an 8-bit DDA were constructed and tested, as well as a pulse synchronizer circuit for synchronizing the DDA to a master system clock. The results were presented in tabular form along with sample timing diagrams.

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## DESIGN OF A MICROPROCESSOR-BASED DIGITAL DEAD-RECKONING TRACER

Researcher: Midshipman 1/C Duane H. Wilson

Adviser: Research Professor Richard L. Martin

Currently, U. S. Navy ships are equipped with electromechanical devices for maintaining a geographic plot of the ship's travel over the earth, called a Dead-Reckoning Tracer (DRT). The purpose of this project was to develop a digital DRT based on an 8080A microprocessor.

The main result of the project was the design and development of the software for the microcomputer. Inputs were simulated, and the results from the microcomputer's program were compared to the theoretical expectations.

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PRESENTATIONS

ELECTRICAL ENGINEERING DEPARTMENT

MARTIN, Richard L., Associate Professor, "Use of the MMD-1, An INTEL 8080A Microcomputer System, at the U. S. Naval Academy." Paper read at ASEE Mid-Atlantic Section Meeting, Pennsylvania State University, 13-14 May 1977.

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SANTORO, Ralph P., Professor, "Theory of Microcomputers." Keynote address presented to the Fall Meeting of the Chesapeake Section of the American Association of Physics Teachers, Virginia Beach, Virginia, 13 November 1976.

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## ENGINEERING AND TECHNOLOGY DEPARTMENT

Lieutenant Colonel Walter E. Boomer, USMC, Chairman

The research performed by members of the Engineering and Technology Department reflects the wide range of expertise present in the faculty. The Operations Analysis Study Group placed the greatest emphasis on research and was supported by an annual grant from the Chief of Naval Operations (OP-953). The funds provided assisted the Group in conducting a "cooperative program of operations research studies in Tactical Development and Evaluation in all warfare areas with faculty members working on joint tasks with the Office of the Chief of Naval Operations (OP-953) and Fleet Tactical Development and Evaluation activities."

Another category of research by the Operations Analysis Study Group is "in-house" analysis, in support of Naval Academy operations or programs, on an as-solicited basis. The Graduate Performance Evaluation System (GRAPES) is a continuous activity in this category.

Pioneering work in Brain Wave analysis was continued by one member of the faculty, evoking nationwide interest in the research performed.

The large number of midshipmen projects reflect the Department's belief that student research under the supervision of an interested and dedicated faculty is a broadening and valuable educational experience. The opportunity to utilize the knowledge and skill gained during the prior three intensive years of work gives First Class midshipmen an appreciation and understanding of the usefulness and importance of their education.

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SPONSORED RESEARCH

ENGINEERING AND TECHNOLOGY DEPARTMENT

A LONGITUDINAL STUDY OF THE RELATIONSHIP BETWEEN A MIDSHIPMAN'S NEUROLOGICAL PROFILE AND VARIOUS ASPECTS OF PERFORMANCE AT THE UNITED STATES NAVAL ACADEMY

Researcher: Associate Professor Karel Montor

Sponsors: United States Naval Academy and the National Naval Medical Center

By building on the technology developed in signal-processing research, the United States Naval Academy has developed a Signal Analysis Laboratory capable of on-line neurological measurement and sophisticated evaluation of data on the Academy's time-sharing computer.

During the summer of 1976, 1227 members of the Class of 1980 were individually administered a 15-minute brain wave test. The data are being analyzed to determine possible relationships between an individual's neurological profile and his academic and physical performance characteristics.

In this study it was found possible to determine whether a midshipman's reading abilities are neurologically or academically based and whether a person in academic trouble was born right- or left-handed. Those whose brain waves are significantly different from the norm were found to have academic grades significantly different from the norm.

In a related study, perhaps the largest blood testing ever done in this country was completed, with nearly all members of the Class of 1980 tested. Ten different blood characteristics--among them protein content, albumen, cholesterol, uric acid, creatinine, and sgot--were studied to determine their possible relationship with academic achievement.

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AVIATOR FLIGHT PERFORMANCE IN A PROLONGED HIGH-STRESS ENVIRONMENT

Researcher: Midshipman I/C Edgar Enochs

Advisers: Associate Professor Karel Montor, Professor Bruce Johnson,  
Lieutenant Commander John Burt, USN

Sponsor: Trident Scholar Program

The purpose of this study was to determine whether a meaningful correlation exists between some quantifiable element of a pilot's neurological activity and his performance at the controls of an aircraft with particular emphasis on degraded performance as a result of "mental fatigue." The study represents the simultaneous development of two initially independent areas of investigation and their eventual integration for the purpose of correlation analysis.

Because the evaluation of pilot performance has traditionally been subjective in nature, a new and unique system for quantifying pilot performance was developed using the Singer GAT-1B Link Flight Simulator. A system was also developed for monitoring and recording pilot neurological functions in a cockpit environment.

Significant changes in pilot performance and neurological functions were observed as a result of sleep deprivation, holding all other factors as constant as possible. An apparent trend was observed relating changes in pilot performance to changes in a pilot's pre-flight neurological state described in terms of cross correlation and coherence function analysis of evoked potential tests. Ground work was laid for further investigation into the possibility of predicting pilot performance, based on a comparison of the pilot's current neurological state to a previously recorded baseline and developing neurologically-based criteria for pilot duty cycles.

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#### A SENSITIVITY ANALYSIS OF SPAM TO USER INPUTS

Researchers: Midshipmen 1/C Mark E. Alcamo and Russell S. Harper

Adviser: Research Professor Thomas D. Burnett

Sponsor: Chief of Naval Operations (OP-095)

SPAM (Search Pattern Assessment Model) is a computer program written in Fortran which, through simulation, evaluates the effectiveness of sonobuoy search patterns. In this study the sensitivity of detection probability is evaluated as a function of different user inputs. Inputs considered include: time-late, target's initial position and speed, acoustic variability, and characteristics of the tactical situation. The study was made under the assumption that the user is searching for a submarine using an arc pattern covering the quadrant it is assumed to be transitting through.

This analysis has shown that the probability of detecting a submarine using SPAM is sensitive to certain user inputs. When the user is correct in his assumptions about the target, then time-late is not highly significant, although the probability of detection does decrease as time-late increases. When the user is incorrect in his assumptions about the target, time-late magnifies his error and becomes a highly significant factor.

The probability of detection is also sensitive to the assumed speed of advance of the target. An assumption of his speed only 2 knots off can decrease the probability of detection significantly, especially as time-late increases.

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ENGINEERING AND TECHNOLOGY DEPARTMENT

The buoy-target geometry selected for the 50 and 150 hertz monitoring frequencies has a noticeable impact on the probability of detection. The buoy-target geometry selected for the 300 hertz frequency does not significantly affect the probability of detection.

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THE EFFECT OF OCEAN WAVE CONDITIONS UPON NAVAL GUNFIRE SUPPORT PERFORMANCE  
BY WORLD WAR II VINTAGE DESTROYERS AND AMPHIBIOUS SHIPS

Researchers: Midshipmen I/C Dennis D. Antonio and Daniel Thompson

Adviser: Lieutenant Commander Roland T. E. Bowler, III, USN

Sponsor: Chief of Naval Operations (OP-095)

Ocean wave and Pacific Fleet naval gunfire support exercise data are analyzed to determine the relationship between ocean wave conditions and naval gunfire support performance. Correlation analysis is applied to determine any relationships existing between the two sets of data. Other statistical methods are applied to provide supporting evidence.

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THE INCORPORATION OF O.A. DETECTION TECHNIQUES INTO A COMPUTER  
SIMULATION

Researchers: Midshipmen I/C Joseph L. Barnes and Mark A. Slivka

Adviser: Lieutenant Commander Gilbert M. Marlowe, USN

Sponsor: Chief of Naval Operations (OP-095)

The simulation program, "SHIPS", used by the Seamanship and Tactics Department, uses a linear relationship as the basis for its sonar detection model. In its place, a detection model based on Figure of Merit and the propagation of sound in water is substituted. The result is a more realistic simulation with the same objective as the initial simulation: the training of midshipmen in the maneuvering of a nautical vessel while tracking the movements of another vessel.

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## SHIP-SPACING: A HAND-HELD CALCULATOR TO SOLVE OPTIMAL SPACING

Researchers: Midshipmen 1/C LaSelle Booker and Glen H. Blinde

Adviser: Lieutenant Commander John F. Sigler, USN

Sponsor: Chief of Naval Operations (OP-095)

During antisubmarine warfare (ASW) action it is often the responsibility of a subordinate commander to conduct the initial ASW search and/or attack as on-scene commander of a search and attack unit (SAU). Among other decisions he must make are the spacing of units under his command. The criteria for selecting ship spacing must be based on the mode availability, the number of available ships, the threat, the mission and the operational situation. Using these criteria the problem has been modeled and programmed for entry as input to a hand-held calculator producing optimal spacing as output.

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THE EFFECT OF OCEAN WAVE CONDITIONS ON NAVAL GUNFIRE SUPPORT  
EFFECTIVENESS FOR MODERN DESTROYERS AND CRUISERS: AN ANALYSIS

Researchers: Midshipmen 1/C Peter M. Caulk and Stephen Merchant

Adviser: Lieutenant Commander Roland T. E. Bowler, III, USN

Sponsor: Chief of Naval Operations (OP-095)

The stability of a warship in conditions of variable sea state may affect its performance as a weapons platform. This paper researches what effect ocean wave conditions have on naval gunfire support performance.

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## BACK AND FORTH SEARCH FOR VARIOUS LATERAL RANGE CURVES

Researchers: Midshipmen 1/C Philip J. Corbett and Robert W. Andersen

Adviser: Commander James L. Bagby, USN

Sponsor: Chief of Naval Operations (OP-095)

Previous models of the Back and Forth Search Scenerio have been limited to sensors with Uniform Lateral Range Curves, which do not exist in the fleet today. This model allows the user to input the lateral range curve for any sensor to determine which unit gives the highest probability of detection for a given tactical situation.

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## THE ADDITION OF POSTOPTIMALITY ANALYSIS CAPABILITY TO A LINEAR PROGRAMMING CODE

Researcher: Midshipman I/C Bradford F. Lewis

Adviser: Associate Professor W. Charles Mylander

Sponsor: Chief of Naval Operations (OP-095)

The program LPREVISE optimizes linear programming models. It performs its main function yet is incapable of postoptimal analysis. LPREVISE requires that the user has previously created a file containing the data representing the linear programming model. The data file is easily built but is difficult to change. This project has added right-hand-side ranging and objective row ranging to LPREVISE and has created a program which modifies the data file.

This project has added depth to the computer-aided linear programming facilities available to the midshipmen taking NA312 at the U.S. Naval Academy. LPREVISE can still be made into a more powerful program by the addition of the upper bounding algorithm and the capacity of the user to specify the initial basis. Both of these additions to LPREVISE would be time consuming and complex but are within the scope of an NA412 project.

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## PROBABILISTIC DETERMINATION OF DIRECT PATH OR CONVERGENCE ZONE CONTACT BY SONOBUOY AS A FUNCTION OF MONITORING TIME

Researchers: Midshipmen I/C Gregory T. Lizama and Leon Jackson, Jr.

Adviser: Research Professor Thomas D. Burnett

Sponsor: Chief of Naval Operations (OP-095)

Decision aids were created to help VP aircraft tactical coordinators determine whether a sonobuoy contact is direct path or convergence zone. A sub-routine, using Bayes Theorem to determine the probability of detection, was developed to augment a pattern evaluation simulation model, SPAM, in order to aid in this determination. The results are based on the assumption that the relative likelihood of direct path and convergence zone detection are a property of a particular sonobuoy pattern and monitoring time.

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## SIMULATION OF TASS CABLE BEHAVIOR DURING SHIP MANEUVERS

Researchers: Midshipmen 1/C David R. Mickle and Irby D. Fogleman

Adviser: Research Professor Thomas D. Burnett

Sponsor: Chief of Naval Operations (OP-095)

Towed Array Surveillance System (TASS) is a hydrophone array that is towed on a cable 1000 to 3500 meters behind the towing vessel. TASS has excellent reception capabilities in a passive mode. However, during ship maneuvers the cable is not straight behind the towing vessel. At such times the information obtained by the TASS hydrophones is not useable, as it is impossible to get accurate bearings to any contact. The purpose of this project is to develop a computer model which simulates the behavior of the TASS cable during ship maneuvers. The intent is to use the model to discover types of turns which minimize the time during which TASS cable information is not useful.

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## ANALYZING SONOBUOY PATTERN EFFECTIVENESS USING COMPUTER SIMULATION

Researchers: Midshipmen 1/C Jeffrey A. Morse and George McKenzie

Adviser: Associate Professor W. Charles Mylander

Sponsor: Chief of Naval Operations (OP-095)

This project compares the effectiveness of the Navy's brushtac and distributive field patterns within a controlled scenario. It investigates the value of the individual buoy within the patterns. It develops a new formula for buoy spacing for the distributive field pattern and compares it to the two most commonly used formulas. A new sonobuoy pattern called pentac is developed. It appears to be superior to the commonly used patterns for the scenarios investigated.

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## SOLVING THE OPTIMAL SONOBUOY DEPTH SCHEDULE PROBLEM THROUGH THE APPLICATIONS OF A SIMULATION MODEL

Researchers: Midshipmen 1/C Jeffrey A. Morse and George McKenzie

Adviser: Lieutenant Commander Gilbert M. Marlowe, USN

Sponsor: Chief of Naval Operations (OP-095)

The present doctrine in VP aircraft submarine search tactics calls for a mix of alternate deep and shallow buoys depths when accurate acoustic propagation loss profiles are not available. An inference

has been made that this tactic might be worse than all deep or all shallow sonobuoy configurations. A simulation model is used to analyze varying environmental, operational, and submarine characteristics on varying depth schedules to determine the optimal sonobuoy depth schedule.

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#### A DECISION AID RELATIVE TO THE REPLACEMENT OF A MALFUNCTIONING SONOBUOY

Researchers: Midshipmen 1/C Daniel T. Vallerie and Robert F. Nichols

Adviser: Research Professor Thomas D. Burnett

Sponsor: Chief of Naval Operations (OP-095)

When a sonobuoy malfunctions, a decision must be made concerning buoy replacement. To date, decisions have been made based upon past experience and the aircraft commanders' intuition. Pattern degradation in detector probability and the increase in expected length of time to reach a detecting buoy where replacing a malfunctioned buoy are concepts known to the aircraft commander. Presentation of quantifiable aids concerning these variables to aid his decision are the basis of this study.

The results of the degradation in pattern performance showed that the BRUSHTAC pattern malfunctioned buoy did not affect the pattern performance. There was a slight increase in the amount of time to reach the maximum pattern detection probabilities when a buoy was simulated to be down. The overall pattern probability of detection was not affected adversely. This resulted from the fact that the BRUSHTAC pattern has a highly saturated coverage area. If a submarine happened at one time instant to be in the gap in the coverage due to the missing buoy, it would soon transit into an area covered by another buoy and would be detected. This accounts for both the increase in time to obtain the maximum probability as well as the insignificant probability of detection change. There was a maximum detection probability for the pattern with no buoys missing of .57, while the minimum value was .55 with a buoy down.

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#### EXPANDING AREA SEARCH: A MONTE CARLO SIMULATION

Researchers: Midshipmen 1/C Bruce R. Weiss and James E. Eckrich

Adviser: Commander James L. Bagby, USN

Sponsor: Chief of Naval Operations (OP-095)

The random search and patrol model as developed in Chapter 7 of Naval Operations Analysis, 2nd edition, addresses the situation where the target remains in an area of fixed dimensions. An extension of this model

addresses an expanding circular area search and suggests theoretical upper and lower bounds for the probability of detection. Three real-life simulation models are developed using Monte Carlo techniques, thus forming a basis of comparison between theoretical and simulation scenarios. The differences in detection probabilities lead to several important conclusions concerning the scenario's initial underlying assumptions.

The computer programs developed have further room for refinement in efficiency and in incorporating an initial reference point for the searcher so that the searcher can begin his search immediately upon entry in the expanding circle datum area. Another program in which the target is randomly and uniformly placed repeatedly throughout the search sequence could be easily developed to further test the theoretical model (although this model is not very realistic).

If the programs as written and/or refined were run repeatedly using several hundred sets of parametric values, a tabularized reference could be created in which a client could enter the table with a given set of parameters and obtain a canned probability of detection.

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#### YP CRAFT PREVENTIVE MAINTENANCE WORKLOAD

Researchers: Commander James L. Bagby, USN, and Lieutenant Commander Roland T. E. Bowler, III, USN

Sponsor: Commanding Officer, Naval Station, Annapolis

An analysis of the Preventive Maintenance Subsystem (PMS) requirements for the Naval Station's fleet of YP craft generated a summary of annual man-hours for each enlisted rate or trade skill. The report included some subjective considerations to assist local management, as well as a suggested method of converting the man-hour requirements into required manning levels after integration of non-PMS workload requirements.

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#### GRADUATE PERFORMANCE EVALUATION SYSTEM (GRAPES)

Researcher: Lieutenant Commander Roland T. E. Bowler, III, USN

Sponsor: Director, Division of Professional Development

Serving as a form of USNA self-accountability, GRAPES captures the recent (1973) graduate's appraisal of his preparation for effective and competitive service as a junior officer. Analysis of the individual

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ENGINEERING AND TECHNOLOGY DEPARTMENT

questionnaire responses provides identification of specific strengths and weaknesses of the USNA program, for these responses are based upon seven years of personal experiences by these young men as midshipmen and as junior officers.

It is the long-term goal of GRAPES eventually to join such graduate feedback with an objective measure of graduate success in the military profession. Such a measure would represent an annual, macroscopic appraisal of the total USNA program (including the admissions sub-program) for year-to-year comparison among USNA graduating classes and for comparison between USNA and competitive commission sources.

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STATISTICAL ANALYSIS OF BRIGADE COMPANY PERFORMANCE

Researchers: Research Professor Thomas D. Burnett, Lieutenant Commander James R. Fitzgerald, USN, and Lieutenant Commander Gilbert M. Marlowe, USN

Sponsor: Commandant of Midshipmen

This research, which commenced in March 1977, consists of statistical analyses of data existing on all individual midshipmen, to determine correlations, then statistical models which might permit further understandings, predictions, and management actions oriented towards the observed, curiously large variability in performance among the 36 companies.

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RESEARCH COURSE PROJECTS

ENGINEERING AND TECHNOLOGY DEPARTMENT

RECYCLING WASTE MATERIALS FROM THE MIDSHIPMEN FOOD SERVICES DIVISION  
OF THE U.S. NAVAL ACADEMY

Researchers: Midshipmen 1/C Mark B. Anderson and Theodore H. Brown

Adviser: Associate Professor W. Charles Mylander

The Mess Officer of the Midshipmen Food Services Division of the United States Naval Academy has requested that a project be undertaken to determine the feasibility of implementing a collection of waste materials for recycling after use in the Midshipmen's Wardroom. This project investigates paper, glass, and aluminum waste and makes recommendations based on the waste output of the wardroom, costs associated with its collection, and the expected return from recycling firms.

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A COMPARISON OF THE CLASS OF 1976 PERFORMANCE VERSUS OTHER SOURCE  
OFFICER PERFORMANCE AT SURFACE WARFARE OFFICER SCHOOL

Researchers: Midshipmen 1/C Eugene J. Bojarski and C. T. Hutchinson

Adviser: Lieutenant Commander Roland T. E. Bowler, III, USN

As graduates leave the Naval Academy and enter various warfare specialty schools, it is desired to follow their performance. This study analyzes the USNA graduates' performance against the performance from the other officer sources at one of the warfare schools, the Surface Warfare Officer School in Newport, Rhode Island. Also, it determines if correlation exists between an Academy officer's performance while at SWOS and his performance as a midshipman.

It is important to note that the authors' conclusions were based on results generated from one year's data only. The results and conclusions are a good indication of the officer's performance at SWOS but since a sample size of one was used, the results may not be truly indicative of all officer source performances in the future.

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AN EVALUATION OF THE EFFECTIVENESS OF USNA CANDIDATE GUIDANCE BLUE  
AND GOLD PROGRAM

Researcher: Midshipman 1/C Thomas P. Breyer

Adviser: Major Edward A. Smyth, USMC

The effectiveness of the recruiting done by the Blue and Gold Information Program is analyzed. A data base of the target population is developed. Against this base, the number of candidates to the



## RESEARCH COURSE PROJECTS

## ENGINEERING AND TECHNOLOGY DEPARTMENT

Naval Academy covering three years and the number of Blue and Gold members are compared for the various areas of the country using linear regression. Measures of association are applied.

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### PLEBE STUDY TIME 1977

Researchers: Midshipmen 1/C James J. Cardosi and Peter W. Varvaris

Adviser: Commander James L. Bagby, USN

Midshipmen Gygax and McDaniel in the spring of 1976 investigated plebe time allocation through 14 activity categories. Changes were introduced by the Naval Academy administration in the summer of 1976 with the goal of increasing study time for plebes. This project analyzes plebe time allocation in the same manner as the spring 1976 study and determines if more study time was indeed made available for the class of 1980.

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### ADVERTISING, MARKETING, AND NAVAL RECRUITING

Researcher: Midshipman 1/C Brian Dowsley

Adviser: Associate Professor Karel Montor

The project was designed to provide an opportunity to learn about marketing and determine its value to naval recruiting. The study included learning about the history and modern-day methods of marketing, including specific attention to the controllables and uncontrollables. Many meetings were held with members of the Naval Recruiting Command and the advertising agencies that did and do handle the Navy's promotional program. An analysis of the future of naval advertising was presented, including conclusions as to the effectiveness of the present program along with recommendations for future operations.

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### FOOD SERVICES MIS: A COMPUTER-BASED SYSTEM TO AID MIDSHIPMEN FOOD SERVICE DIVISION IN MENU PRODUCTION

Researchers: Midshipmen 1/C John C. Grace and William J. Mickler

Adviser: Research Professor Thomas D. Burnett

Midshipmen Food Service Division hand calculates the amount of ingredients and items required for food preparation based on a meal count. A computer-based Management Information System is developed

RESEARCH COURSE PROJECTS

ENGINEERING AND TECHNOLOGY DEPARTMENT

to create and maintain ingredient and recipe data files which can be processed to obtain the ingredients of an entree and to calculate the required amounts in units of issue based on a given meal count.

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A COMPARISON OF MIDSHIPMEN ACADEMIC AND BIO-CHEMICAL PROFILES

Researcher: Midshipman I/C Brendan L. Gray

Adviser: Associate Professor Karel Montor

The purpose of the study was to compare blood profiles with academic performance, and physical education grades of midshipmen. The study involved 1,073 plebes of the Class of 1980 and blood analysis instrumentation at the National Naval Medical Center at Bethesda. Within the assumptions and limitations of the study, the conclusions were reached that the data supported the hypothesis that there exists a significant relationship between blood sample parameters and academic, performance, and physical education grades. Several suggestions were made as to areas for future research, with implications of the study being discussed.

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AN OPEN-COMPETITIVE ADMISSIONS POLICY VERSUS THE CONGRESSIONAL ADMISSIONS POLICY AT THE U.S. NAVAL ACADEMY

Researchers: Midshipmen I/C Samuel J. Locklear and Edward A. Christofferson

Adviser: Major Edward A. Smyth, USMC

The existing system utilized for appointing midshipmen to the United States Naval Academy is a Congressional appointment policy. Congressional involvement in the admission process assures a demographic distribution of midshipmen. The desirability of an Open-Competitive Admissions policy is considered. A simulated Class of 1981 is created utilizing qualified nominees in three distinct categories (females, minorities, others). The simulation is then compared to the actual Class of 1981 and a comparative statistical analysis is performed depicting differences in average candidate multiples and Scholastic Aptitude Test (SAT) scores. The Chi-Square, Goodness of Fit test is then utilized to verify the demographic differences between the simulation and the actual class.

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A COMPARISON OF MIDSHIPMEN PERSONALITY INDICES TO COLOR PREFERENCE

Researcher: Midshipman 1/C Patrick M. Walsh

Adviser: Associate Professor Karel Montor

The purpose of the study was to compare midshipmen color preference with their respective personality indices. Two thousand four hundred and eleven color tests were performed on the Classes of 1977, 1979, and 1980. Within the assumptions and limitations of the study, the conclusions were reached that: (1) there are significant differences in personality that can be measured by indice differences between groups that favor red versus any other color, and (2) there are significant findings in the brain wave portions of the test related to high frequency differences in voltage levels between red and yellow choices.

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PUBLICATIONS

ENGINEERING AND TECHNOLOGY DEPARTMENT

BAGBY, James L., Jr., Commander, USN, Research Professor Thomas D. BURNETT, et.al., Operations Analysis Study Group, "Midshipman Journal, Academic Year 1976-1977." Volume 5, Parts I and II, 1977.

For abstracts, see "Sponsored Research" and "Research Course Projects," Engineering and Technology Department.

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BAGBY, James L., Jr., Commander, USN, et. al., Operations Analysis Study Group, Naval Operations Analysis. Annapolis: United States Naval Institute, 1977.

This is the Second Edition of this textbook for the course NA311, "Introduction to Naval Operations Analysis." The book is also an unique reference for the theory behind prevailing probability models for naval tactical scenarios, many of which are addressed topically by fleet tactical publications.

The work on this revision was accomplished jointly by all seven members of the Operations Analysis Study Group.

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BOWLER, Roland T. E., III, Lieutenant Commander, USN, and Commander James L. BAGBY, Jr., "YP Preventive Maintenance Workload." Report, Operations Analysis Study Group, August 1976.

For abstract, see "Sponsored Research," Engineering and Technology Department.

\*\*\*\*\*

CARDOSI, James J., Midshipman I/C, and Midshipman I/C Peter W. VARVARIS, "Plebe Study Time, 1977." Operations Analysis Study Group Report, May 1977.

For an abstract, see "Research Course Projects," Engineering and Technology Department.

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## MECHANICAL ENGINEERING DEPARTMENT

Professor Vincent J. Lopardo, Chairman

Faculty and midshipmen research in the Mechanical Engineering Department covers many of the areas of specialization contained in Mechanical Engineering. These include research in direct energy conversion, fluid mechanics, heat transfer, acoustics, dynamic effects, stress corrosion cracking, fracture mechanics, and welding technology.

Research support is supplied through funds from government agencies. The David W. Taylor Naval Ship Research and Development Center, Annapolis Laboratory, provides opportunities for several faculty members to work on research projects during the intersessional period. In addition, some faculty members undertake independent research activities which enhance the research effort in this Department. Including all levels of research activity, 16 civilian faculty members have been active in the research activities of the Department this year.

An important part of the Department's research effort during the year has been the involvement of midshipmen in independent research, design, or development projects.

Supporting the research effort in Mechanical Engineering are the sophisticated laboratory facilities located in the new Rickover Hall Complex. The Department maintains facilities for performing experimental research in several areas: fluid mechanics, solid mechanics, materials science, experimental-stress analysis, control systems, mechanical vibrations, heat transfer, and thermodynamics.

The primary driving force behind the Department's research is the real need for the faculty to stay abreast of technological developments in the many diversified areas of mechanical engineering in order to be more effective classroom teachers.

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## COANDA/REFRACTION NOISE SUPPRESSOR DESIGN

Researcher: Associate Professor Thomas W. Butler

Sponsor: Naval Air Engineering Center

Since ground run-up tests for Navy jet engines are extremely noisy, an effective exhaust noise suppression system is needed. One of the simplest and most effective systems currently under development is the method which utilizes the Coanda effect to "turn" exhaust gases through 90°. Utilizing previously completed scale model test results which employed Coanda surfaces, the present project attempted to identify parameters and dimensions so that various size noise suppressors can be easily designed. A final report is in preparation.

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## PYRAMIDAL INDENTATION OF TWO-PHASE MATERIALS

Researcher: Associate Professor Thomas W. Butler

Sponsor: Naval Academy Research Council

Because of the rapid increase in research in materials, greater use is being made of the hardness test to evaluate material properties. The theoretical basis of the hardness test is well established for homogeneous materials; it is not for composite, two-phase materials. Consequently, the objective of the current work is to determine force-indentation relationships for indentation by pyramidal indenters of two-phase materials.

A theoretical investigation is being made of the forces required to indent a type of ductile layered two-phase material by a rigid smooth rectangular-based pyramid. The semi-infinite material to be considered has a central rigid-perfectly plastic phase and contiguous regions on either side of the central phase which have a yield strength either higher or lower than the central phase. Using the upper bound plasticity limit theorem and kinematically admissible velocity fields, upper bound indentation forces can be found for the entire range of indentation sizes. The model of deformation which has been chosen for the purposes of upper bound calculation will be based on physical observations of how the metal deforms.

Currently, an earlier, plane, wedge indentation problem is being reviewed and expanded to determine most suitable kinematically admissible velocity fields for analysis.

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CLOSED BRAYTON CYCLE ENGINE

Researcher: Associate Professor Elliott E. Dodson

Sponsor: David W. Taylor Naval Ship Research and Development Center,  
Annapolis Laboratory

Closed cycle power systems are attractive for both subsurface and surface applications. Utilizing current gas turbine technology, these systems are capable of providing high reliability, good performance at part as well as full load (i.e., good fuel economy), low levels of structure-borne noise, compact design, and adaptability to a variety of heat sources.

The Navy's interest in examining the applicability of closed-cycle engines to their needs has resulted in a program which includes design, fabrication, and testing of a 40-hp Laboratory Closed Brayton Engine. The engine provides NSRDC with a test vehicle for evaluating closed Brayton hardware and software technology applicable to a wide variety of compact closed Brayton engines.

This particular phase of the Closed Brayton Engine project was concerned with the engine testing program at NSRDC and encompassed the determination of test data accuracy, its extension to calculated results, and the development of a method to aid in the interpretation of experimental results.

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THREE DIMENSIONAL TRANSONIC AERODYNAMIC LOADS

Researcher: Professor Robert A. Granger

Sponsor: Office of Naval Research

The project was to develop a method to calculate the unsteady loads due to an oscillating finite wing in transonic flow. A method was developed, but because of the awesome complexity and intractability of the problem, it was impractical to continue the project. The computing time would be prohibitively expensive. The project was dropped. A report dated 30 September 1976 to ONR contains all the salient aspects of the study.

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COST ANALYSIS OF MARINE SANITARY DEVICES

Researcher: Associate Professor John O. Geremia

Sponsor: Naval Sea Systems Command

A cost benefit study was made of two methods of treating and/or handling of waste material aboard ships. One method is to collect and hold the material during transit of zones where discharge is restricted; discharge is ultimately effected outside the zone or to a barge or port facility. This is the CHT method. The second method is to treat sewage on board so that it may be discharged within a restricted zone. This is the MSD method (Marine Sanitary Device). The analysis shows that CHT's are cheaper to operate over their lifetimes, but the MSD's have a considerable political influence and their development should be continued.

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EVALUATION OF MECHANICAL PROPERTIES AND FRACTURE BEHAVIOR OF 4-INCH THICK TITANIUM WELDMENTS

Researcher: Assistant Professor Dennis F. Hasson

Sponsor: David W. Taylor Naval Ship Research and Development Center,  
Annapolis Laboratory

The objective of the study was to evaluate the effect of heat input and out-of-position welding on the mechanical and stress-corrosion-cracking (SCC) behavior of satisfactory welds. All welds are to be produced by gas-metal-arc pulsed welding of 4-inch thick titanium plate. In addition, a special weld configuration was utilized to produce specimens for specific evaluation of the heat-affected-zone. Major and interstitial chemical element analyses, metallography, dynamic tear tests, wedge-opening-load, SCC tests, and fractography will be performed on the weldments. All weldments have been produced and a large part of the mechanical tests have been performed. Fractography and SCC tests are planned for the near future. A report on the effect of heat input on the mechanical properties of 4-inch welds is in preparation. Two additional reports, one on the heat-affected-zone study and the other on out-of-position welding, will be prepared.

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SPONSORED RESEARCH

MECHANICAL ENGINEERING DEPARTMENT

STRESS-CORROSION-CRACKING BEHAVIOR OF ARMOR PIERCING METALLIC ALLOYS

Researchers: Assistant Professor Dennis F. Hasson and Assistant Professor James A. Joyce

Sponsor: Naval Surface Weapons Center, White Oak Laboratory

Information leading to an understanding of the stress-corrosion-cracking (SCC) behavior of depleted uranium alloys is required to support the design of an advanced system. SCC tests, which utilize a cantilever beam apparatus, will be performed in moist salt water air. The crack growth rate will be recorded and from the appropriate fracture mechanics analysis, the critical stress intensity for SCC,  $K_{ISCC}$  will be determined. Supporting metallographic, chemical, and fractographic analyses will be performed off site. The results will be presented in journal articles.

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WAVE ACTIVATED TURBINE GENERATORS

Researcher: Associate Professor Richard A. Hirsch

Sponsor: United States Coast Guard

This is a continuation of previous work which developed the equations describing the buoy motion, water column motion, air column motion, turbine dynamics, and generator output. The present work involves: (1) analysis of field test data, (2) design of a test apparatus to simulate the air column and activate the turbine/generator, (3) conduct of laboratory tests, (4) development of linearized equations of motion, (5) validation of either the linear or non-linear model, and (6) optimization of the buoy design. The test apparatus was designed and fabrication is 95% complete. Laboratory tests will commence 1 May. The linearized model was developed. The final report will be published during June 1977.

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SINGLE SPECIMEN  $J_{IC}$  FRACTURE TOUGHNESS TESTING

Researcher: Assistant Professor James A. Joyce

Sponsor: National Science Foundation

A method for single specimen tests to obtain the  $J_{IC}$  fracture parameter has been developed and is in the final verification stage. Visitors from American Society for Testing of Materials, Naval Research Lab, and the Nuclear Regulatory Agency, Westinghouse



Research Laboratory, Frankford Arsenal, and the David W. Taylor Naval Ship Research and Development Center, Annapolis Laboratory, have observed these tests at the Naval Academy. After verification of the method is completed, tests will be run to determine the range of applicability of the  $J_{IC}$  parameter. Preparations for these tests are now underway and the tests themselves should begin before June 1977.

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#### STRESS CORROSION DATA ACQUISITION

Researcher: Assistant Professor James A. Joyce

Sponsor: David W. Taylor Naval Ship Research and Development Center,  
Annapolis Laboratory

The object of this work is to design and develop a micro-processor controlled data acquisition system for monitoring long time tests like those involved in corrosion or stress corrosion cracking study. Such a system is now being build. Sub-system elements are now being interfaced and a system test will be ready by June 1977.

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#### ANALYSIS OF TORPEDO TUBE LINKAGES

Researcher: Associate Professor William M. Lee

Sponsor: David W. Taylor Naval Ship Research and Development Center,  
Annapolis Laboratory

A study of the forces generated in the torpedo tube muzzle/shutter-door linkage system is presented. The results bracket actual operating experience, since the forces are based on coefficients of friction of zero and one. No friction data for the materials involved could be found. Results indicate that friction can cause up to a five-fold increase in the force required to actuate the linkage system. Recommendations for future work include the generation of needed friction data and an analysis of forces generated by the torpedo tube slide valve which was not originally included.

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## THE EFFECTS OF DRAG REDUCING POLYMERS ON THE TURBULENCE CHARACTERISTICS OF THE HYDRAULIC JUMP

Researcher: Assistant Professor Thomas H. Reif

Sponsor: Naval Academy Research Council

Researchers have been studying the characteristics of the hydraulic jump since the days of Leonardo da Vinci. However, to date little is actually known about the mean flow and Reynold's stresses in this highly dissipative flow field. Though extensive measurements of these quantities have been made by Rouse, Tien, and Nagaratnam (1958) in an air model of the hydraulic jump, no such data base is known to exist for an actual jump in water.

Hence, one objective of this investigation is to study the mean flow and turbulence characteristics of an actual hydraulic jump and to compare these results to the classical results obtained with the air model. The second objective is to add the known drag reducing polymer polyacrylamide (Calgon TRO-375) to the flow field and to subsequently study the effects of variable concentration of this polymer on the mean flow and Reynold's stresses within the hydraulic jump.

These experiments are being conducted in the fluids lab of the Mechanical Engineering Department at the USNA. A two-channel laser-doppler anemometer is being used in conjunction with the 10 ft. long, 12 in. deep, and 4 in. wide open-channel flume. Preliminary results suggest discrepancies between the actual and air model of the hydraulic jump as well as a decrease in the turbulence intensity with the addition of the drag reducing polymer.

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## FLOW NOISE PREDICTION IN SUBMARINE HIGH PRESSURE PIPING SYSTEMS

Researcher: Professor John P. Uldrick

Sponsor: David W. Taylor Naval Ship Research and Development Center, Annapolis Laboratory

An experimental investigation of the structure-borne noise in piping systems conveying high pressure air has been carried out at the Naval Ship Research and Development Center in Annapolis utilizing the Submarine Fluid Dynamics high pressure air facility.

The objectives of this research are to develop procedures for predicting the structure-borne noise in the high pressure air piping systems on submarines and to employ these procedures for developing

acoustic design criteria for inclusion in design specifications for the piping systems on the new class of submarines.

During the past two or three years various experimental tests have been performed with the aim toward correlating the 1/3 octave structure-borne acceleration levels measured on the surface of pipes conveying high pressure air with the pipe structure, pressure, flow-rate, and other pertinent parameters. This study has led to an empirical relationship among the variables wherein the desired noise predictions can be made.

Several computer-aided analysis and graphics programs have been written and validated for predicting the noise induced by the flow of high pressure air in 1 1/2", 2", and 4" straight pipe. Based upon a limited quantity and quality of data which can be processed and analyzed using present procedures, a continuation of the study will be pursued to include an experimental and analysis system in which the computer and its peripherals can receive data, analyze the results, and display the findings in near real time. When this computer-aided system is implemented, enhancement and confidence in the methodology to predict flow noise will be realized, and a major step toward having reliable information for the ship designer will be available for him to design into his piping system certain noise criteria in the actual planning stages of the design.

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#### POTENTIAL NAVAL APPLICATIONS OF DIRECT ENERGY CONVERSION DEVICES

Researcher: Associate Professor Chih Wu

Sponsor: Naval Academy Energy-Environment Study Group  
(Navy Energy and Natural Resources R&D Office, Code MAT03Z)

Direct energy conversion devices may be used as prime movers, refrigerating devices, etc. and are endowed with characteristics which are well-suited to diverse naval applications. There is a real and urgent need for substantial fundamental work in this area to be initiated. Developments of thermoelectric converters, thermionic generators, photovoltaic cells, MHD systems, and fuel cells have been surveyed. A comparison has been made between conventional energy conversion and direct energy conversion in size, weight, and efficiency. Potential utilization of these direct energy conversion devices to our Navy has been studied.

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SPONSORED RESEARCH

MECHANICAL ENGINEERING DEPARTMENT

STRESS CORROSION CRACKING STUDIES OF HY STEEL WELDS

Researcher: Assistant Professor Robert D. Wyckoff

Sponsor: David W. Taylor Naval Ship Research and Development Center,  
Annapolis Laboratory

The researcher developed a testing program for the investigation of susceptibility of HY steel weldments to hydrogen embrittlement and to stress corrosion cracking. The program was developed to ascertain which metallurgical variables control susceptibility to stress corrosion cracking. The program developed is presently underway at DWTNSRDC and the techniques developed are being used in addition by the Naval Research Laboratory in parallel investigations.

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## ACTIVATION ENERGY OF SUPERPLASTIC FLOW

Researcher: Visiting Professor John A. Belk

The effect of temperature and strain rate on the true stress, true strain, tensile behavior of Zn-Al superplastic alloys allows a measurement of the strain-rate sensitivity, work-hardening characteristics and activation energy for deformation. The influence of alloy additions and microstructure on the properties of Zn-Al eutectoid alloys was studied.

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## THERMAL RESPONSE

Researcher: Associate Professor Elliott E. Dodson

This work represented the initial phase of a program directed toward the study of those thermal factors which most significantly affect human performance within closed spaces, those combinations of factors providing environments which tend to maximize performance and, ultimately, a method of evaluating any given environment relative to maximized performance.

Present work has been limited to two simple environments--classroom and studyroom--and has consisted in the gathering of experimental data with regard to the influence of six factors upon thermal comfort. The six factors are temperature, humidity, mean radiant temperature, air velocity, thermal resistance of clothing, and activity level.

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## DETERMINATION OF THERMAL EXPANSION COEFFICIENTS OF FRP's USING ELECTRICAL RESISTANCE STRAIN GAGES

Researcher: Associate Professor Jack H. Smith

The objective of this work was to develop a technique to use to determine the thermal coefficients of expansions in orthotropic fiber reinforced plastics. Tests were performed on various graphite reinforced polymers and gave results which were repeatable and which compared favorably with more traditional techniques.

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STRESS CORROSION DATA ACQUISITION

Researcher: Midshipman 1/C Gary Colton

Adviser: Assistant Professor James A. Joyce

In a senior systems class project, Mr. Colton had the task of interfacing an Intel 8080 microprocessor and a QUANTEX 600-series tape deck so that data stored in RAM can be transferred to tape in a format compatible with the Tektronix 4051 terminals. This project is part of an ongoing research project to develop a moderate cost long time data acquisition system.

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VIBRATION SYSTEM SIMULATION

Researcher: Midshipman 1/C Christopher P. Cook

Adviser: Professor J. Alan Adams

It has been shown that the simulation of vibrating systems on a refresh computer-driven display can be very useful in teaching and demonstrating the principles of vibration. Software is required to generate the necessary display. A program will be developed which includes a menu and allows the use of springs, masses, and dashpots in a generalized, two-degree-of-freedom vibrating system. Special attention will be given angular vibration since no software currently exists to handle this type of display.

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COMBUSTION ANALYSIS OF HYDROGEN IN A GAS TURBINE

Researcher: Midshipman 1/C Jose Corpus

Adviser: Assistant Professor Eugene L. Keating

This investigation considers the storage and combustion problems of a hydrogen-fueled gas turbine. The combustion analysis has calculated the specific fuel consumption as a function of compressor pressure ratio, and combustion chamber inlet and outlet temperature, and other important parameters. The results obtained indicate hydrogen has a lower specific fuel consumption than Navy distillate. In addition, a similar parametric analysis has been made for shaft horsepower versus specific fuel consumption.



RESEARCH COURSE PROJECTS

MECHANICAL ENGINEERING DEPARTMENT

Also, the combustion chamber has been analyzed to determine combustion products for various operating conditions including the combustion of hydrogen. Finally, the study considers current technology on the storage of liquid hydrogen.

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IMPROVED TENSION-TORSION TESTING MACHINE

Researcher: Midshipman 1/C Gregory A. Morrison

Adviser: Associate Professor Thomas W. Butler

A device has been constructed which tests the strength of cylindrical metal specimens by simultaneously applying both shearing and axial forces. The device utilized an untwisting steel cable to apply the torsional load, while an axial load is applied by a traditional testing machine. The loading paths were found to be linear and repeatable within better than 5%.

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COMPUTER-AIDED LEARNING IN DYNAMICS

Researcher: Midshipman 1/C Michael L. Schmit

Adviser: Associate Professor William M. Lee

This was a project to develop the display of two mechanisms of kinematic interest for the PDP-1140 picture system. The two mechanisms are the conventional slider-crank mechanism and a simple four-bar mechanism.

The programs have been written for the system in such a manner that the various geometric parameters can be varied over a range as well as the speed of the driving link.

It is planned to build a library of such mechanisms which can be used in the Dynamics course (EM232) to assist in the study of rigid body motion.

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HASSON, Dennis F., Assistant Professor, co-author, "Explosion Tear Test Performance of Two-Inch Thick Ti-6Al-2Cb-1Ta-0.8 Mo Alpha-Beta Processed Plate and Weldments," David W. Taylor Naval Ship Research and Development Center, Report MAT 77-33, May 1977.

Two-inch thick alpha-beta rolled Ti-6Al-2Cb-1Ta-0.8Mo titanium alloy plate and weldments produced by the gas-metal-arc-welding pulsed-current process and the gas-metal-arc-welding spray process were evaluated. Comparisons were made with weldments made by the gas-tungsten-arc-welding-hot wire process evaluated previously. Explosion tear tests on crack starter specimens demonstrated that alpha-beta processed base plate withstands plate surface strains in excess of 6% and weldments made by the three processes can endure strains in excess of 3% before propagating a crack. Mechanical properties, including strength, Charpy V-notch toughness, and dynamic tear toughness, are similar for weldments made by the three processes. The results of the explosion tear tests made in this investigation indicate that 6-pound pentolite charges are too severe for evaluation of 2-inch thick Ti-621/08Mo plate.

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KEATING, Eugene L., Assistant Professor, co-author, "The High Temperature Oxidation of Tetrafluoroethylene," The Journal of Chemical Physics, 66(February 1977).

The high temperature oxidation of tetrafluoroethylene ( $C_2F_4$ ) in excess argon has been studied behind reflected shock waves. Kinetic data were obtained for three fuel/oxidant ratios and all experiments were carried out in the temperature and total pressure ranges 1670-2500°K and 4.0-6.9 atm, respectively. The rate of formation of  $COF_2$  was monitored in emission at  $5.5\mu$  while the rate of reaction of  $CF_2$  was monitored simultaneously in absorption at 2804 Å. The Arrhenius rate constant for the elementary reaction  $CF_2 + O_2 \rightarrow COF_2 + O$  is given by the expression  $k_5 = (2.01 \pm 0.30) \times 10^{13} \exp(-26500 \pm 600/RT)$  cm<sup>3</sup>/mole·sec. Based on both the simultaneous experimental measurements and analytical mechanistic considerations, it was shown that the initial rate of  $COF_2$  formation could be utilized to evaluate  $k_5$  under all experimental conditions. However, owing to the presence of competing reactions, the initial rate of reaction  $CF_2$  could not be utilized in all cases to evaluate the elementary rate constant  $k_5$ .

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## PUBLICATIONS

## MECHANICAL ENGINEERING DEPARTMENT

KEATING, Eugene L., Assistant Professor, co-author, "Shock Tube Studies of Fluorocarbon Pyrolysis and Oxidation." Proceedings of Symposium on the Physical Chemical Characterization of Fluoride Materials, American Chemical Society Meeting, San Francisco, California, 1976.

Considerable effort has been expended in the area of fluorocarbon chemistry to obtain relevant thermochemical data and to understand the elementary processes important in the pyrolysis and oxidation of fluorocarbons. Both single-pulse and conventional shock tube studies have played an important role in elucidating the kinetics of fluorocarbon pyrolysis and oxidation. Shock tube studies of the oxidation of tetrafluoroethylene ( $C_2F_4$ ) and the thermal stability of carbonyl fluoride ( $COF_2$ ), one of the most common high temperature oxygenated fluorocarbon species, have not only led to the development of fluorocarbon reaction mechanisms and thermochemical data but also the establishment of shock tubes as a valuable tool in studies of high temperature fluorocarbon chemistry.

In studies of high temperature fluorocarbon systems, numerous results have been published dealing with  $C_2F_4$  oxidation,  $COF_2$  thermal stability, reactions of  $COF_2$  with  $H_2$  and  $CO$ , decomposition of  $COF$  and thermochemistry and bond dissociation energies of  $CF_2$ ,  $COF_2$ , and  $COF$ . These investigations of the high temperature kinetics of fluorocarbons have also resulted in the development of reaction mechanisms for the  $C_2F_4-O_2$ ,  $COF_2$ , and  $COF_2-H_2$  systems. A review of the investigation techniques and most significant findings in the various studies of high temperature fluorocarbon systems are presented.

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KEATING, Eugene L., Assistant Professor, co-author, "Wind-Powered Heat Pump Design Study - A Potential Naval Alternate Energy System," Report, USNA-EPRD-18, June 1976.

An assessment of a low-energy application using wind power at remote naval installations is reported. The design analysis of a wind-powered heat pump for use at remote military installations is presented. Climatological data for Amundsen, Antarctica and Yakutat, Alaska, support the detailed design study of such a wind energy system. Using design information developed, a wind turbine with a blade diameter of 9.12m (30 ft) is shown to be sufficient to heat a four-room building in Yakutat, Alaska and a five-room building in Amundsen, Antarctica.

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KEATING, Eugene L., Assistant Professor, co-author, "The Influence of Combustion With Pressure Exchange on the Performance of Heat Balanced Internal Combustion Engines." (For abstract, see Publications, Aerospace Engineering Department.)

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KEATING, Eugene L., Assistant Professor, co-author, "The Naval Academy Heat Balanced Engine (NAHBE)." (For abstract, see Publications, Aerospace Engineering Department.)

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REIF, Thomas H., Assistant Professor, co-author, "An In Vitro Study of Transendothelial Albumin Transport in a Steady State Pipe Flow at High Shear Rates," Transactions ASME, Journal of Fluids Engineering, 98(1976), 488-493.

The effect of high wall shear rates on the uptake of  $^{131}\text{I}$ -albumin by the arterial wall has been studied in vitro using common carotid arteries excised from anesthetized dogs and perfused with a steady state flow of homologous serum. Wall uptake was found to depend nearly upon wall shear rate. The overall transport of  $^{131}\text{I}$ -albumin from the perfusing fluid to the vessel wall appears to be rate controlled by a shear dependent fluid-wall interface process. This study was carried out at high shear rates for flows which were transitional and turbulent. Because of the complexity of such flows, direct measurements of pressure drop were used to determine the shear rate at the vessel wall. Simultaneous pressure drop and flow measurements allowed the determination of the friction factor as a function of Reynolds number; results obtained at the higher Reynolds numbers correspond to those for a rigid pipe with a relative roughness of 0.05.

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WU, Chih, Associate Professor, "Direct Energy Conversion Devices and Their Possible Naval Applications," Report USNA-EPRD-32, October 1976.

Direct energy conversion devices may be used as prime movers, refrigerating machines, etc. and are endowed with characteristics well suited to diverse naval applications. Despite this, not much effort has been invested in the U.S. Navy in their development. There is a real and urgent need for substantial fundamental work in this area to be initiated. Developments of thermoelectric converters, thermionic generators, photovoltaic cells, MHD systems and fuel cells are surveyed. A comparison between conventional energy conversion and direct energy conversion in size, weight, and efficiency is made. Potential utilization of these direct energy conversion devices to our Navy is studied.

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PRESENTATIONS

MECHANICAL ENGINEERING DEPARTMENT

ADAMS, J. Alan, Professor (with David F. ROGERS, Professor), "Analytical Engineering Drawing with Computer Graphics." Paper read at WABA Symposium on Computers in Education, U.S. Naval Academy, May 1977.

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BELK, J. Anthony, Visiting Professor, "Education of Military Officers." Paper read at USNA/DWTNSRDC Sigma Xi Club, April 1977.

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BELK, J. Anthony, Visiting Professor, "Superplastic Alloys." Paper read at USNA ASME Student Chapter, April 1977.

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CORPUS, Jose, Midshipman 1/C, "Hydrogen Production from Fission Product Waste Heat." Paper read at American Nuclear Society Eastern Regional Student Conference, North Carolina State University, Raleigh, North Carolina, 24-26 March 1977.

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GEREMIA, John O., Associate Professor, "Induction Heating of a Conducting Fluid in a Tube." Paper read at 12th Southeastern Conference on Heat Transfer and Fluid Dynamics, Charlottesville, Virginia, 6-8 June 1976.

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GEREMIA, John O., Associate Professor, "Modern Experimental Techniques in Mechanical Engineering." Paper read at Carnegie-Mellon University Seminar, December 1976.

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GRANGER, Robert A., Professor, "Bioplasma." Invited guest lecturer at Baltimore Chapter, American Society for Mechanical Engineering, 28 February 1977.

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JOYCE, James A., Assistant Professor, "Computer Interactive JIC Fracture Toughness Testing." Paper read at Nuclear Regulatory Commission, special meeting on ductile fracture test methods, Silver Spring, Maryland, December 1976.

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PRESENTATIONS

MECHANICAL ENGINEERING DEPARTMENT

JOYCE, James A., Assistant Professor, "Computer Interactive JIC Fracture Toughness Testing." Paper read to Materials Division personnel at National Bureau of Standards, Gaithersburg, Maryland, 20 April 1977.

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KEATING, Eugene L., Assistant Professor, "Basic Programming in a Thermodynamic Curriculum." Paper read at WABA Symposium on Computers in Education, USNA, May 1977.

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WU, Chih, Associate Professor (with John O. GEREMIA, Associate Professor), "Effect of Heat Transfer to a Conducting Fluid by an Electromagnetic Field." Paper read at ASME Winter Annual Meeting, New York, New York, 1976.

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WU, Chih, Associate Professor, "Effect of Thermal Electrification on the Transport Properties of a Particulate System." Paper read at meeting of American Institute of Chemical Engineers, Atlantic City, New Jersey, 1976.

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WU, Chih, Associate Professor, "Use of Solid Waste as an Auxiliary Energy Source for Naval Bases." Paper read at 13th Annual Meeting of the Southeastern Seminar of Thermal Science, Clemson, South Carolina, 14-15 April 1977.

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## NAVAL SYSTEMS ENGINEERING DEPARTMENT

Professor Peter F. Wiggins, Chairman

Research in the Naval Systems Engineering Department plays a vital role in the professional enrichment of both midshipmen and faculty. During Academic Year 1976-1977, faculty members and midshipmen participated in numerous and varied projects in the fields of marine engineering, ocean engineering, and naval architecture.

A variety of projects were undertaken, both funded and unfunded. These include faculty research in the areas of internal engine analysis, water jet studies, sediment shear strength, wave energy studies, hydro-mechanics laboratory development, energy conservation, ocean energy resources, neutron activation studies, condenser studies, ship stability studies, boundary layer studies, off-shore structure studies, environmental protection programs, and faculty-sponsored midshipmen projects in the areas of undersea laboratory design and construction, advanced marine vehicles, and reactor heat transfer studies.

The undersea laboratory is ready to be tested and used for further midshipmen research efforts in the Chesapeake Bay. This major undertaking, encompassing faculty-midshipmen interaction in design, construction, and future utilization, is reflective of the dedication to midshipmen involvement found in the Naval Systems Engineering Department.

Support for research is found in many sources, from departmental operating funds to contracts and grants from such diverse organizations as the Naval Academy Research Council, the Naval Sea Systems Command, the U.S. Coast Guard, and the Naval Ship Research and Development Center.

Research and design projects, as in the past, have continued to display the originality and variety typical of the Naval Systems Engineering Department's faculty and undergraduate majors. The Department will continue to pursue an aggressive commitment for research for the midshipmen and faculty that provides the needed scholarly activity to maintain an outstanding undergraduate program. Many of the faculty members of the Department are internationally known for their contributions in their respective fields.

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SPONSORED RESEARCH

NAVAL SYSTEMS ENGINEERING DEPARTMENT

SCALING PROBLEMS OF AN OCEAN THERMAL ENERGY CONVERSION PILOT PLANT

Researcher: Professor Arthur E. Bock and Assistant Professor Martin E. Nelson

Sponsor: Naval Academy Energy-Environment Study Group  
(Civil Engineering Laboratory)

This project developed a list of variables important to operation and similitude scaling of ocean thermal energy conversion condensers and evaporators; dimensional analysis was undertaken using time, length, mass, and temperature as the fundamental dimensions. Final results included a set of dimensionless parameters significant in the similitude scaling of ocean thermal energy conversion condensers and evaporators. A literature survey was conducted and a list of approximately 30 variables important to the problem was developed.

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AN INVESTIGATION OF RELAMINARIZATION BY SUCTION

Researcher: Assistant Professor Sander Calisal

Sponsor: Naval Academy Research Council

The objective of this project is to obtain data on relaminarization by suction. This investigation concentrates on detailed study of the flow close to the suction slit to observe and record the effect of suction on velocity profiles and related boundary layer quantities.

For the possible range of suction available pressure variation along a flat plate with and without suction, close to 100 profiles are recorded and studied at three different locations along the plate. One of these locations is upstream of the slit location and two are downstream. The mean stream velocity is changed over the range 20 ft/sec to 60 ft/sec. All the profiles are plotted and compared to find the effect of suction on the profile shapes. Tentatively one can claim that:

- a) The suction slit seems to generate a vortex effect very close to the wall, increasing the velocity in the sublayer and decreasing the flow in the region of the "law of the wall."
- b) Suction slit as also claimed by other authors seems to be an inefficient way to relaminarize the flow.

With the available data a curve-fitting procedure is started to test the logarithmic and bilogarithmic laws that are valid for uniform suction. It is hoped that one can express the effect of the slit suction in terms of "effective suction values."

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THE EFFECT OF TURBULENCE ON SHIP WAVE GENERATION

Researcher: Assistant Professor Sander Calisal

Sponsor: Naval Academy Research Council

Ship resistance calculations are usually based on Froude's hypothesis. This essentially separates viscous and gravity effects. The effect of turbulent boundary on wave generation is usually ignored. Recent developments showed that:

- a) Any change in the boundary layer parameters affect the wave resistance or wave spectrum.
- b) Turbulent boundary layer can be represented as a viscoelastic medium.

It is the opinion of this investigator that these two statements can be used together to redefine the ship wave generation problem. Two major shortcomings, however, are:

- 1) No numerical quantities or functions reflecting the viscoelastic properties of the ship turbulent boundary layer exist.
- 2) Difficulties in the measurement of the ship turbulent boundary layer are extremely complex.

These two factors are partially avoided by changing the boundary layer of a ship with a rather well-known wake and by leaving calculation of the numerical parameters of the viscoelastic medium as a result of the experimental studies.

A well-known ship model series 60 blick 60 is towed behind the flat plate. Total resistance and lateral wave height cuts are recorded. The numerical analysis is in progress.

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AN ASSESSMENT OF TWO-CREW SURVIVAL SYSTEMS

Researcher: Associate Professor Roger H. Compton

Sponsor: United States Coast Guard

An analytical study is made of the conditions in which two survival systems can be expected to operate. The two systems are: (1) a float-off (i.e., no davit launch) system, and (2) an evacuation slide (as used by commercial airlines) system.

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NAVAL SYSTEMS ENGINEERING DEPARTMENT

For the first system, a quantification of the characteristics of the flow over a sinking process (i.e., time to sink, range of list, range of trim, etc.) has been completed with exceptionally meager results. This effort is being followed by the development of an analytical model of the flow. This analytical study will be verified by a simple experimental program.

The second system is being studied by Professor G. W. Somers of Anne Arundel Community College under contract to the Naval Academy.

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DYNAMIC RESPONSE OF SUBMERGED OCEAN STRUCTURES TO SURFACE-WAVE LOADINGS

Researchers: Assistant Professor Thomas H. Dawson and Professor Michael E. McCormick

Sponsor: Naval Academy Research Council

In recent years, an increasing amount of attention has been paid to the problem of wave loadings on submerged bodies in connection with ocean structures such as underwater storage tanks and light-weight vehicle submersibles. The customary approach taken in these investigations has been to calculate the wave forces on the structure from the flow field of classical water-wave theory: vertical forces are determined from the pressure field assuming the structure does not disturb the flow field; horizontal forces are determined from the acceleration field through the introduction of an inertial coefficient so chosen as to account for the disturbance caused by the body itself. Of principal concern has been the determination of the total forces exerted on the body, regarded as rigid, so as to allow proper design of anchoring or analysis of rigid body motions.

The objective of the present work is to establish improved methods for calculating the forces on and the response of ocean structures to surface-wave loadings using analytical and numerical methods which will allow for the complex interaction of the structure and the wave field. Scaling laws have been developed for the response of off-shore structures to surface waves. The response of a towing cable to rough seas has also been examined.

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CAVITY FLOW ANALOGY TO WATER JET FLOW

Researcher: Research Professor Jack W. Hoyt

Sponsor: Naval Sea Systems Command

A high-speed free-surface recirculating water channel has recently been installed at the Naval Academy. This channel is being used to study the surface waves on a cavitating elliptically-shaped body. The body was



#### SPONSORED RESEARCH

#### NAVAL SYSTEMS ENGINEERING DEPARTMENT

designed according to potential-flow theory, and is cut off at the maximum thickness, leaving a cavitating wake. The surface waves on the cavity are theoretically an exact analogy to the surface waves on a water jet in air. The waves will be photographed and analyzed. The effects of water speed and cavitation index, and the use of polymer solutions instead of water, will be examined to verify that the surface waves are analogous to those on the surface of water jets. In this way it is hoped to provide a better explanation of water-jet instabilities, leading to better nozzle design. Initial testing has been completed and shakedown of the water channel and apparatus essentially finished. Testing should be complete by 1 July 1977.

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#### OCEAN ENERGY SYSTEMS RESEARCH AND PROGRAM MANAGEMENT

Researcher: Professor Michael E. McCormick

Sponsor: Energy Research and Development Administration (ERDA)

The energies of wind-waves, ocean currents, and salinity gradients are presently under consideration as alternate resources. The research, development, and demonstration programs are under the direction of Professor McCormick.

In addition to the program management, theoretical research in the three areas was carried out to help determine the direction of the programs. Studies of the power delivered to a linear array of wave-energy converters in a random sea were performed, resulting in two papers. The effects of removal of power from the Florida current was also analyzed, and the conclusion was made that severe flooding of the Florida coast may occur. Finally, salinity gradient power predictions were made for both osmotic systems and reverse electrodialysis systems.

Six invited papers and two journal papers (in preparation) resulted from the research.

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#### APPROACHES TO COMPUTER-AIDED SHIP COMPARTMENTATION

Researcher: Assistant Professor Bruce C. Nehrling

Sponsor: Naval Ship Engineering Center

Ship compartmentation is the process of assigning location, size, and shape to each of the compartments, or the basic elements of space required in a ship. As the design is refined, the internal configuration of the ship will progressively evolve from a rudimentary arrangement of primary decks and bulkheads to a complete set of spatial interrelationships.

The intent of this research project was threefold: (1) to delineate the spatial characteristics inherent in a conventional ship's internal topology; (2) to postulate the requirements for a computer-aided ship compartmentation procedure; and (3) to examine existing computer oriented methods which possibly could facilitate the ship compartmentation process. In this investigation an extensive review of existing naval and related civil architectural procedures was conducted.

To date, no one has developed an adequate procedure for performing this largely non-analytic design task though the development of such a procedure appears to be a feasible undertaking.

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#### EARLY STAGE DESIGN PREDICTIONS ON THE INTACT TRANSVERSE STABILITY OF A SHIP

Researcher: Assistant Professor Bruce C. Nehrling

Sponsor: Naval Academy Research Council

The objective of this continuing research project is the derivation of a set of analytic expressions which will enable naval architects to predict the intact transverse stability indices of a monohull displacement ship during preliminary design.

Data on the intact stability characteristics of existing ships is being collected or computed. A statistical analysis and step-wise regression is being performed on the accumulated data. Based on these results, a series of expressions is being developed which should enable naval architects to predict adequately what the influence of a ship's hull form parameters will be on its intact transverse stability.

It is anticipated that this information will improve the procedure for defining the ship's initial lines as well as minimizing the possibility of not satisfying a given set of stability criteria.

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#### AN INVESTIGATION OF THE HYDRAULIC CHARACTERISTICS OF SURFACE CONDENSER WATERBOXES AND INLET PIPING

Researcher: Assistant Professor Clyde C. Richard

Sponsor: Naval Academy Research Council

The hydraulics of condenser waterboxes is not well-understood. Although smooth, turbulent free flow through the waterbox and into the condenser tube bundle is desired, practical limitations on size and cost often negate good hydraulic design.

This study investigates the details of condenser waterbox hydraulics. A plastic, scale model waterbox operating in a test loop is used to study visually the flow distribution of the circulating water. The model parameters are such that the nature of the flow closely approximates that found in the full-scale system.

Recirculation and flow separation found in the areas of geometry changes are mapped using air bubbles and dye tracing methods. Velocity measurements using pitot tubes quantitatively establish the magnitude of the flow maldistribution.

A reduction in turbulence and flow distribution is accomplished by installing turning vanes at critical locations. These vanes, designed to have minimal pressure drop effects, direct the flow into areas previously seen to have large recirculation zones. To quantify the improvement of the flow hydraulics due to the turning vanes, a flow separation parameter is established. Plots of the velocity with and without turning vanes and the flow separation parameter clearly show the need for turning vanes in condenser waterboxes.

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#### APPLICATION OF A GENERALIZED DYNAMIC THEORY TO PHYSICAL SYSTEMS

Researcher: Lieutenant Pharis E. Williams, USN

Sponsor: Naval Academy Research Council

A generalized Dynamic Theory based upon the adoption of a set of three dynamic laws which are generalizations of the classical thermodynamic laws was previously conceived by this researcher. An important role in this theory is played by an integrating factor which makes the energy exchange with the environment a total differential and leads to the definition of a mechanical entropy.

Equilibrium and stability conditions for dynamic systems are derived and together with the principle of increasing entropy provide a geometrical structure from which the theories of relativity, Maxwells' electromagnetism, and quantum effects may be derived. Thus the Dynamic Theory is shown to unify the various branches of physics into one theoretical structure.

For systems requiring a description in terms of thermodynamic and mechanical variables the theory yields a five-dimensional manifold in which the principle of increasing entropy produces five equations of motion in a space-time-mass continuum. These equations replace the Navier-Stokes, continuity, and constituent equations of hydrodynamics. An additional prediction of the theory is magnetic moments in the absence of electrical charges.

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SPONSORED RESEARCH

NAVAL SYSTEMS ENGINEERING DEPARTMENT

AN INVESTIGATION OF POSSIBLE CORRELATIONS BETWEEN INDIVIDUAL PILOT  
PERFORMANCE AND NEUROLOGICAL FUNCTIONS

Researcher: Midshipman 1/C Edgar R. Enochs

Advisers: Professor Bruce Johnson, Lieutenant Commander John Burt, USN,  
and Associate Professor Karel Montor

Sponsor: Trident Scholar Program

The purpose of this study was to determine whether a meaningful correlation exists between some quantifiable element of a pilot's neurological activity and his performance at the controls of an aircraft, with particular emphasis on degraded performance as a result of "mental fatigue." The study represents the simultaneous development of two initially independent areas of investigation and their eventual integration for the purpose of correlation analysis.

Because the evaluation of pilot performance has traditionally been subjective in nature, a new and unique system for quantifying pilot performance was developed using the Singer GAT-1B Link Flight Simulator. A system was also developed for monitoring and recording pilot neurological functions in a cockpit environment.

Significant changes in pilot performance and neurological functions were observed as a result of sleep deprivation, holding all other factors as constant as possible. An apparent trend was observed relating changes in pilot performance to changes in a pilot's pre-flight neurological state described in terms of cross correlation and coherence function analysis of evoked potential tests. Ground work was laid for further investigation into the possibility of predicting pilot performance based on a comparison of the pilot's current neurological state to a previously recorded baseline and developing neurologically-based criteria for pilot duty cycles.

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AN ANALYSIS OF SEDIMENT SHEAR STRENGTH

Researcher: Midshipman 1/C Robert C. Hanson

Adviser: Associate Professor Neil T. Monney

Sponsor: Trident Scholar Program

The purpose of this project was to evaluate the effectiveness of the vane shear sediment strength test, and correlate vane shear test data with triaxial test data for tests on a clayey-silt from a water depth of 600 feet in the Santa Barbara Channel. Most empirical relationships used in offshore foundation design are based on triaxial test data

from land soils accumulated over many years of testing, but virtually all of the sediment strength tests are performed with the vane shear device. Vane shear tests and triaxial tests were performed on the same sediment samples. The samples were preconsolidated in the triaxial, all at pressures of 25 psi, 50 psi, 75 psi, and 90 psi. Consolidated Undrained Triaxial (CUT) tests were performed with constant measurement of porewater pressure. These initial tests (22 samples) indicate that, for a clayey silt of this type, the vane shear strength is about 10% of that measured in CUT tests.

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## TRANSIENT NON-BOILING HEAT TRANSFER IN A REACTOR COOLANT CHANNEL DURING FLOW COASTDOWN

Researcher: Associate Professor Martin E. Nelson

The conventional heat transfer coefficient relationships for internal forced-convection heat transfer have been compared to a numerical solution. The numerical solution models fully developed turbulent flow through a parallel plate channel with heat generation in both walls. This study involved modifying the code to handle a time-varying fluid velocity, which simulates a flow coastdown, and comparing with transitional heat transfer coefficients, which are based on a time-in-variant fluid velocity.

The code has been modified by having the coolant's mean velocity input as a specified function of time. On the basis of the mean velocity, the coolant's velocity profile is calculated using the universal velocity profile and eddy diffusivity at each time step. The resulting velocity profile and eddy diffusivities are then input into finite-difference energy equations for the coolant, which are solved simultaneously with the finite-difference wall energy equations.

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## FEASIBILITY STUDY AND PRELIMINARY DESIGN OF A USNA TRAINING SHIP

Researchers: Commander Henry Schmidt, Jr., USN, Associate Professor  
Roger H. Compton, and Assistant Professor Bruce C.  
Nehrling

The advent of women midshipmen at the Naval Academy and the increasing age of the current Yard Patrol (YP) craft assigned to the Academy has established a requirement for a replacement craft. Recently defined training requirements indicate that the new YPs may have substantially different characteristics from those of the existing ships.

The intent of the project is to conduct feasibility studies directed towards full definition of the operational requirements and constraints which must be met by the replacement YP craft. Such constraints as the Naval Station marine railway capability, maintenance concepts, etc., are to be addressed as well as the subject of trade-off studies, where appropriate.

Several preliminary designs are to be initiated from which, along with costs and other related information, design decisions may be made. A reasonable preliminary design will subsequently evolve and will be the basis for specification of the contract requirements. Model testing in the tow tanks will be conducted to support the design process.

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## HYDROGEN PRODUCTION FROM FISSION PRODUCE DECAY (PART I)

Researcher: Midshipman I/C Dale Govan

Adviser: Assistant Professor Martin E. Nelson

A preliminary design study has been made into the use of fission product wastes for the production of hydrogen gas using electrolysis of water.

The part of the study evaluated the energy produced in a waste heat boiler as a function of mass flow rate of fission products used and time of fission produce decay. Four different solidified forms of fission products were considered. The results were obtained by solving the governing energy equations numerically on the computer.

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## HYDROGEN PRODUCTION FROM FISSION PRODUCE DECAY HEAT (PART II)

Researcher: Midshipman I/C Ronald A. Banchak

Adviser: Assistant Professor Martin E. Nelson

This study continued an analysis separately initiated. (See Research Course Project of Midshipman Govan above.) This portion involved evaluating the amount of hydrogen that would be produced as a function of the mass flow rate of steam produced in the waste heat boilers using electrolysis of water. It was found that the overall system efficiency could be increased if the water was pre-heated by the heat rejected in the condenser before it was sent to the electrolyzer. The power for the water electrolysis comes by passing the steam produced in the waste-heat boiler through a turbine-generator, which creates the electrical power needed for electrolysis.

In addition, the energy requirements were investigated to determine how much energy would be needed to liquify and store the hydrogen.

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## MEDUSA WATER SYSTEM/SUPPORT VESSEL

Researcher: Midshipman I/C Peter C. Filkins

Adviser: Associate Professor Neil T. Monney

The work on this project was divided between two areas: The MEDUSA water system, and locating a suitable support vessel for the undersea laboratory. The water system required a review of earlier

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design drawings and field tests to validate these drawings. The drawings required revision; and the field tests identified a cracked elbow. It was replaced with an additional valve so that the system can be drained to guard against freezing. Location of a suitable support vessel presented major difficulties. A surplus LCM-6 was finally located in Norfolk. Initial contacts have been established at the Naval Station, Annapolis, OPNAV, and Norfolk to transfer the LCM-6 to Annapolis. Formal approval and arrangements will be completed in the summer of 1977.

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#### NAVAL ARCHITECTURE OF BODY OF REVOLUTION SUBMERSIBLES

Researcher: Midshipman 1/C Gerald T. Frentz

Adviser: Associate Professor Roger H. Compton

The basic hydrostatic and hydrodynamic characteristics of a body of revolution submersibles were studied. A computer program to develop the hydrostatic curves of form for a mathematically-defined hull was written and applied to a Series 58 form.

A parallel effort involving investigations into two military roles for small submersibles was made. An anti-submarine warfare (ASW) mission and a mine neutralization mission were studied.

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#### SUBMERSIBLE MODEL DYNAMOMETER DESIGN AND CONSTRUCTION

Researcher: Midshipman 1/C Gerald T. Frentz

Adviser: Associate Professor Roger H. Compton

A dynamometer to measure the lift, drag, and pitching moment on a 5' (or larger) submerged body was designed and built. The dynamometer utilizes the hydronautics' 2" block gauges and associated signal conditioning system.

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#### MEDUSA CERTIFICATION AND OPERATION MANUAL

Researcher: Midshipman 1/C Michael Golda

Adviser: Associate Professor Neil T. Monney

Midshipman Golda was responsible for preparing the documentation for certification of the MEDUSA laboratory, and for preparation of the MEDUSA Operations Manual. The certification task involved compiling and editing all previously submitted reports, and preparing written

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assessments of all systems which are related to personnel safety. The information was prepared in the format specified for use for certification of driving systems by the U. S. Navy. Midshipman Golda also began the preparation of the MEDUSA Operational Manual, with special consideration for emergency procedures.

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#### MEDUSA LIFE SUPPORT SYSTEM

Researcher: Midshipman I/C Rande M. Kessler

Adviser: Associate Professor Neil T. Monney

This project involved design, fabrication, and installation of the air supply system components in the MEDUSA support van. The air supply system requires cooling the air from the compressor. The air conditioner which was to be adapted for use in the system did not function properly, and a new, larger unit was located. This required an addition to the baffle system to increase the cooling capacity. The components were installed in the trailer, but final hookup was not completed. The support trailer layout was designed, and the existing interior was dismantled. All rehabilitation of the trailer interior was completed in preparation for installation of all support van components. All major units have been installed and tested, but the total system has not been tested.

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#### COMPARATIVE HYDRODYNAMICS OF U.S. AND SOVIET ESCORT SHIPS

Researcher: Midshipman I/C Kevin Kinports

Adviser: Associate Professor Roger H. Compton

Much interest and concern has been raised as to the relative ability of United States and Soviet surface escort ships to perform in heavy sea conditions. This problem has been addressed in popular and technical publications.

The project will use two 5' models of comparable full-scale destroyer hulls, one of United States design and one Soviet design, and test them in the Naval Academy 120' tow tank. The object will be to: (1) develop response amplitude operators in pitch and heave for each model, and (2) run still water resistance tests on both models. These data will help in comparing the seakeeping and the powering characteristics of the two ships.

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MEDUSA ELECTRICAL SYSTEM

Researcher: Midshipman 1/C Carl R. Moore

Adviser: Associate Professor Neil T. Monney

The following tasks were accomplished during this semester project:

- 1) The habitat wiring was redesigned.
- 2) The fuze box was disassembled, rebuilt, and rewired.
- 3) A poorly installed conduit was replaced.
- 4) An intercom system was installed and wired.
- 5) Sound-powered phones were installed and wired.
- 6) The power and TV cables were installed on the habitat.
- 7) Alternative approaches for attaching the power cable to the support van were evaluated.
- 8) The support van control panel was designed and built.
- 9) Alternative components for use in the monitoring system were investigated.
- 10) The design for the High-Water Alarm Systems was completed.

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THE NAVAL ARCHITECTURE OF RACING HYDROPLANES

Researcher: Midshipman 1/C John G. Rogers

Adviser: Associate Professor Roger H. Compton

An inboard hydroplane is an extremely specialized, high-speed marine vehicle which has received little formal technical input. It is the purpose of this project to develop an understanding of the complex technologies involved in the design and construction of an inboard hydroplane, including high performance propulsion devices (e.g., semi-submerged, supercavitating screw propellers), planing surface hydrodynamics, and structures. This understanding will be developed by study of past designs, as well as the testing of a one-man inboard hydroplane. The cost of the hydroplane is borne completely by the midshipman researcher. The starting point will be a previously constructed and proven design utilizing easily obtainable components, such as a 1200cc Toyota engine. The design will be studied and modified if necessary. The component parts will be tested for performance capabilities using the facilities of the Division of Engineering and Weapons.

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MEDUSA INTERIOR PROJECT

Researcher: Midshipman I/C Timothy Thomson

Adviser: Associate Professor Neil T. Monney

This project involved repairing damage left by vandals who broke into the habitat last summer, plus completion of the interior finish work. The following tasks were completed: (1) carpet (indoor-outdoor) installed, (2) removed damaged sink and installed new sink, (3) painted sections that were completed, (4) installed fire extinguishers, (5) reglued insulation, and (6) installed shower.

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BHATTACHARYYA, Rameswar, Associate Professor, "Floating Structures in Waves," Encyclopedia of Earth Science Series, Vol. XIII, 1976.

The floating structures are built for the purpose of carrying men, material and/or weapons upon the sea. In order to accomplish its mission, a floating structure must possess several basic characteristics. It must float in a stable upright position, and it must be strong enough to withstand the rigors of heavy weather and wave impact. The success of a design for floating structures ultimately depends on their performance in a seaway.

Offshore drilling began in the United States almost twenty-five years ago and various floating structures - the floating, the semi-submersible, and the self-elevating types - have been evolved during the course of time.

A floating structure is designed to operate for a long time in various seaway environments. The basic requirements to withstand severe sea conditions are basic stability features and satisfactory seakeeping performance. There is a specific requirement for the intact stability of floating structures in waves by the U.S. Coast Guard, but there are no requirements for damaged stability. This paper deals with the stability criteria and seakeeping performances of floating structures in waves.

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BHATTACHARYYA, Rameswar, Associate Professor, "Naval Architecture Education and the Computer," Pergamon Press, Great Britain, November 1975.

All practicing naval architects are well aware of the benefits of modern computers in carrying out lengthy routine calculations. What is less often appreciated, however, is that computers now make possible the use of more sophisticated, or more precise, analytical techniques. The purpose of this paper is to show how students of naval architecture are encouraged to use computers at the Naval Academy which strongly supports computer-aided education. There is no attempt in the course on computer application to spell out canned programs. The aim, rather, is to explain the various aspects of the naval architecture calculations and leave it to the individual user to build his own programs to suit his own particular needs. The logic, the precision, and the high speed efficiency of the modern computer when introduced in undergraduate education, can free our profession, not only of the burden of routine work, but of the conservatism of ship design processes of the past.

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CALISAL, Sander M., Assistant Professor, "Effect of Wake on Wave Resistance," David W. Taylor Naval Ship Research and Development Report, November 1976.

Longitudinal wave records and corresponding wave spectra are numerically calculated for a series 60 block 60 ship moving at Froude Number 0.302. Wave resistance values are then computed from the wave spectra. Three different sets of sources as obtained by Adee (1975) are used to represent the ship. The wave height and slope in the far field are calculated by an asymptotic series representation. This representation seems to be an efficient and accurate way to calculate wave height in the far field.

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DAWSON, Thomas H., Assistant Professor, "Impact Testing of Wires," Advances in Engineering Science, NASA CP-2001 (1976), 319-326.

A simple impact test is examined for determining the dynamic tensile response of metal wires. The test consists of fixing one end of a wire specimen and allowing a threaded falling weight to strike the other. Assuming the dynamic stress in the wire to be a function only of its strain, energy considerations show for negligible wire-inertia effects that the governing dynamic stress-strain law can be determined directly from impact-energy vs. wire-elongation data. Theoretical calculations are presented which show negligible wire-inertia effects for ratios of wire mass to striking mass of the order of  $10^{-2}$  or less. The test method is applied to soft copper wires and the dynamic stress-strain curve so determined is found to be about 30 percent higher than the corresponding static curve.

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DAWSON, Thomas H., Assistant Professor, "Scaling of Fixed Off-Shore Structures," Ocean Engineering, 3(December 1976), 421-427.

A simple scaling law is developed for fixed off-shore structures assuming linear structural response and using a Rayleigh correction to account for the structural mass. The accuracy of the law is examined by comparing its predictions with results from an analytic solution for the case of an idealized structure consisting of a rigid deck and uniform support cylinder. Results show agreement within 4% when scale of the system is reduced a full order of magnitude.

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DAWSON, Thomas H., Assistant Professor, Theory and Practice of Solid Mechanics. New York & London: Plenum, 1976.

This book is concerned with advanced topics in solid mechanics and with their applications to engineering problems. Chapter 1 provides an introduction to vectors and Cartesian tensors; Chapters 2 and 3 treat kinematics of deformation and the governing equations of motion; Chapters 4 and 5 deal with classical elasticity; Chapters 6 and 7 deal with thermal elasticity; Chapters 8 and 9 deal with viscous elasticity; and Chapters 10 and 11 deal with plasticity. Appendices on similitude and scale modeling and on numerical methods are also included.

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HOYT, Jack W., Visiting Research Professor, co-author, "Turbulence Structure in a Water Jet Discharging in Air," accepted for publication, Physics of Fluids.

Special purpose high-speed cameras have been developed which enable the detailed visualization of turbulent water jets discharging in air. The laminar-turbulent transition and initial turbulent formation on the surface of the jet is followed by amplified disturbances which result in spray detachment. A very large modification to this process is observed when polymers are added to the water.

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HOYT, Jack W., Visiting Research Professor, co-author, "Waves on Water Jets," accepted for publication, Journal of Fluid Mechanics.

Using high-speed photography, instabilities occurring in high Reynold's number water jets discharging in air have been made visible. These instabilities include the axisymmetric mode accompanying the transition from laminar to turbulent flow at the nozzle exit, spray formation as a culmination of the axisymmetric disturbances, and further downstream, helical disturbances which result in the entire jet assuming a helical form. The final disruption of the jet is due to amplification of the helical waves. It is further shown that the amplification of the helical disturbances is due in part to aerodynamic form drag, since jets discharging into surrounding air moving at the same speed as the jet remain relatively stable, compared with the case when the jet is discharged into stagnant air.

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JEWELL, David A., Visiting Professor, "Possible Naval Vehicles," Naval Research Review, (October 1976); Cover page illustration and pages 1-27.

Naval vehicles, i.e., those vehicles which run in water, in air, and at the air-sea interface, comprise an immense number of possible configurations. A new vehicle morphology is developed, using vehicle lift as the key.

Three primary kinds of vehicles are defined on the basis of vehicle lift: unpowered static, dynamic and powered static. The ways typical vehicles fit the definitions are discussed. Examples of advanced vehicle concepts are displayed to show a trend toward hybrid vehicles.

The hybrid fluidborne vehicle notion is then expanded. A simple graphic display of possible hybrid vehicles is developed, leading to simple designators of sets of vehicles. Certain necessarily general aspects of the performance of advanced vehicles are discussed from this viewpoint, leading to speculations about possible flexibilities of future operations. Current trends in naval vehicle development are then touched on in light of this morphology. A small study of hybrid surface ship concepts is described. This supports the speculation about operational flexibility as a possible advantage of hybrid vehicle. The vehicle morphology is extended to include vehicles such as a bottom crawler, which has partial solid support. Six regions of fluid media in which vehicles operate are distinguished. This defines a lift/media matrix of 18 kinds of possible naval vehicles.

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MCCORMICK, Michael E., Professor, "Waves, Tides, and Salinity Gradients as Energy Sources," published in Proceedings, Environmental Management Seminar, Drexel University, August 1976.

The ocean energy sources of wind-waves, tides and salinity gradients are discussed. The discussion is broken down into three parts: resource potential, technology and environmental considerations.

Waves are shown to have a global power potential of about  $2 \times 10^9$  kW while tides have  $3 \times 10^9$  kW and salinity gradients  $1.5 \times 10^{12}$  kW. The technology of tidal energy conversion has been in existence for many years and, in fact, two tidal-power stations are presently in operation. Wave energy technology has been thought of for many years; however, only recently have practical devices been developed. The technology for salinity gradient has not been developed, although several systems are in the design stage for both pressure-retarded osmosis and reverse electrodialysis.



Environmental problems exist in the conversion of tidal energy in that silt build-up occurs and the salinity wedge is altered. If salinity gradient energy conversion and wave energy conversion are done well away from the estuaries, then the environmental effects are minimal.

\*\*\*\*\*

MONNEY, Neil T., Associate Professor, "Ocean Resource Development," ASME Special Publication, Ocean Engineering Division, Vol. 3, December 1976.

This is a collection of five papers on the development of ocean resources: (1) Ocean Mining; (2) Offshore Petroleum and Gas; (3) Artificial Islands and Platforms; (4) Ocean Refuse Disposal; and (5) Ocean Energy Resources.

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NEHRLING, Bruce C., Assistant Professor, "Recognizing and Using Patterns in Preliminary Ship Compartmentation. Proceedings of the Conference on Computer Applications in the Automation of Shipyard Operation and Ship Design, 1976.

Ship compartmentation is the process of assigning location, size, and shape to each of the compartments, or basic elements of space, required in a ship. As the design is refined, the internal configuration of the ship will progressively evolve from a rudimentary arrangement of primary decks and bulkheads to a complete set of spatial interrelationships.

The internal configuration of conventional ships may be topologically represented as an aggregate of longitudinal, vertical, and horizontal sets. These sets are identified and analyzed. The use of an associative ring structure for maintaining a comprehensive description of these sets is discussed. These sets and the operators required to manipulate them form the foundation for an interactive design procedure. The naval architect develops these sets and operators by means of a special but logical dialogue. Once the ship's internal configuration has been defined it can be fitted into an external hull form. The naval architect may now perform macro or micro revisions to the resulting design. The implementation of this computer assisted compartmentation procedure is briefly described.

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WIGGINS, Peter F., Professor, co-author, "Analysis of Synthetic Coal with Capture Gamma-Rays Using  $^{252}\text{Cf}$ ," Transactions of the American Nuclear Society, 24, (1976), 117.

In the large coal conversion plants now planned, online composition monitoring of process streams at high pressures and temperatures will be required. Results of previous work indicate that interrogation of these streams by neutrons, through the containing walls, and analysis of the emitted gamma-rays is a promising approach to such coal monitoring.

A 20- $\mu\text{g}$   $^{252}\text{Cf}$  irradiation assembly was built at Argonne National Laboratory to investigate this technique quantitatively. (A pilot unit with 1  $\mu\text{g}$  of  $^{252}\text{Cf}$  served for detector calibration and to establish qualitative responses of the major coal elements.) The 20- $\mu\text{g}$  unit was built around a 55-gal paraffin-filled source storage drum under an irradiation space, a 1-ft cubical box of thin Al; boric acid shielded the box. Additional personnel shielding of concrete blocks resulted in a completed assembly about 5 ft<sup>3</sup>.

Rather than using real coal, three synthetic coals of polystyrene (Ch) beads as a base and powders of  $\text{Al}_2\text{O}_3$ ,  $\text{SiO}_2$ ,  $\text{S}_2$ ,  $\text{Ca}(\text{OH})_2$ , Fe,  $\text{MgO}$ ,  $\text{NaCl}$ ,  $\text{K}_2\text{CO}_4$ ,  $\text{NH}_4$ ,  $\text{NO}_4$ , and  $\text{TiO}_2$  were used to simulate coals of about 10, 20, and 30 percent ash.

The captive gamma spectra of the coals are complex. However, quantitative determination of H, Fe, Si, S, C, Cl, Ca, and Ti appear feasible.

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PRESENTATIONS

NAVAL SYSTEMS ENGINEERING DEPARTMENT

COMPTON, Roger H., Associate Professor, "Experimental Naval Architecture at the U.S. Naval Academy." Paper read at American Society of Naval Engineers, Flagship Section, U.S. Naval Academy, Annapolis, Maryland, 15 March 1977.

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DAWSON, Thomas H., Assistant Professor, "Impact Testing of Wires." Paper read at 13th Annual Meeting of the Society of Engineering Science, Hampton, Virginia, 1-3 November 1976.

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HOYT, Jack W., Visiting Research Professor, "Effect of Nozzle Shape and Polymer Additives on Water Jet Appearance." The Joint Applied Mechanics, Fluids Engineering and Bioengineering Conference, New Haven, Connecticut, 15-17 June 1977.

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HOYT, Jack W., Visiting Research Professor, "Drag Reduction and Cavitation in Polymer Solutions." Paper read at Ship Performance Department Hydromechanics Colloquium, David W. Taylor Naval Ship Research and Development Center, Annapolis, Maryland, 10 February 1977. (This paper was also presented to the Department of Engineering Science and Mathematics, University of Florida, Gainesville, Florida, 19 November 1976; to Hydranautics, Incorporated, Laurel, Maryland, 28 January 1977; and to the Department of Mechanical Engineering, University of Toronto, 24 February 1977.)

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McCORMICK, Michael E., Professor, "Energy from the Ocean." Paper read at the Swarthmore Society of Sigma Xi, Swarthmore College, Swarthmore, Pennsylvania, 10 December 1976.

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McCORMICK, Michael E., Professor, "Ocean Energy Sources." Paper read at the Air Pollution Control Association Conference on Alternate Forms of Energy, Brookhaven National Laboratory, 14 October 1976.

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McCORMICK, Michael E., Professor, "Ocean Energy Sources." Paper read at the International Conference on Energy from the Oceans, The Technical University of Denmark, Lyngby, Denmark, 14 April 1977.

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PRESENTATIONSNAVAL SYSTEMS ENGINEERING DEPARTMENT

McCORMICK, Michael E., Professor, "Ocean Thermal Energy Conversion."  
Paper read at the Joint Meeting of Southern New England Section of  
the American Society of Naval Engineers and the American Society of  
Mechanical Engineers, 18 November 1976.

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McCORMICK, Michael E., Professor, "Wave Power Predictions from Various  
Wave Spectra." Paper read at the Ocean Wave Climate Symposium,  
National Oceanographic and Space Administration, Washington, D. C.,  
12 July 1977.

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McCORMICK, Michael E., Professor, "Waves, Tides, and Salinity Gradients  
as Energy Sources." Paper read at Drexel University, 23 August 1976.

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NEHRLING, Bruce C., Assistant Professor, "Recognizing and Using Patterns  
in Preliminary Ship Compartmentation." Paper read in Gothenburg,  
Sweden, June 1976. (See Publications, above.)

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NELSON, Martin E., Assistant Professor, "Transient Non-boiling Heat  
Transfer in a Reactor Coolant Channel During Flow Coastdown." Paper  
read at the Winter Meeting of the Society of the American Nuclear  
Society, Washington, D.C., 17 November 1976.

\*\*\*\*\*

RICHARD, Clyde C., Assistant Professor, "Nuclear Reactor Safety."  
Paper read at the United States Naval Academy Student Branch of the  
American Nuclear Society, U.S. Naval Academy, Annapolis, Maryland,  
21 May 1977.

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## WEAPONS AND SYSTEMS ENGINEERING DEPARTMENT

Lieutenant Colonel Joseph J. Blum, USAF, Chairman

It is the policy of the Weapons and Systems Engineering Department to provide and maintain an environment in which research activities contributing to the professional growth of the faculty and outstanding midshipmen may flourish. Such research, in addition to keeping both faculty and midshipmen abreast of today's rapidly advancing technology, ultimately improves the academic environment by providing examples of and solutions to existing problems. Where research is based on problems posed by the U.S. Navy, as much of it is, the association causes the academic environment to be more relevant to the professional development of midshipmen.

The Weapons and Systems Engineering Department recently experienced a quantum growth in its laboratory facilities in Maury Hall. The improved environment and wide-ranging facilities reflect the broad and varied interests of the faculty, which include physics, medical engineering, electronics, mechanical, and electrical engineering. Although the laboratories are primarily designed to complement midshipman classroom instruction, it is anticipated that faculty members will also use these facilities for their own individual research, and exceptional midshipmen will have an environment capable of supporting a wide range of individual interests.

Faculty research is regularly undertaken by nearly all civilian members of the Weapons and Systems Engineering Department and on occasion by some military members as well. Funding for research activities is available from several sources, including grants or contracts from various federal agencies, as well as funding support from within the Naval Academy. Current contracts have been made by faculty members with both the Naval Electronics Systems Command and the Naval Air Systems Command. Excellent faculty and midshipmen research relations have additionally been established with the David W. Taylor Naval Ship Research and Development Center, Annapolis Laboratory. Sponsored research projects being conducted by faculty members include the investigation of a dynamic model for the fuel control on a gas turbine engine and hybrid computer simulation of missile systems.

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SPONSORED RESEARCH

WEAPONS AND SYSTEMS ENGINEERING DEPARTMENT

FREQUENCY ALLOCATION STUDY

Researcher: Assistant Professor Charles G. Brockus

Sponsor: Naval Electronics System Command

The purpose of this research is to determine families of frequencies, to be used for tactical communications purposes, in which no intermodulation products would be generated at a level sufficient to interfere with proposed satellite communications downlink-frequencies.

The specific objectives are to incorporate current results of measured intermodulation products observed on shipboard, with information on signal levels required for receiver desensitization, into previous guidelines for determining families of frequencies suitable for use in tactical communications.

A computer program is to be developed which can generate appropriate families of frequencies, subject to guidelines used for previous allocations. The families must meet further restrictions for protecting the guardband of satellite communications receivers and preventing generation of intermodulation products at downlink-frequencies at a level to desensitize receivers.

Three factors of the present status of the project have led to a request for extension: (1) project initiation at a date later than proposed; (2) late arrival of critical information; (3) and the massive size of some necessary data files.

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A GENERAL PURPOSE FLUID LOGIC/FLUID CONTROLLED GRIPPING MECHANISM FOR TELEOPERATORS AND ROBOTS

Researcher: Assistant Professor Kenneth A. Knowles, Jr.

Sponsor: Naval Academy Research Council

Time-study analysts break up all human industrial tasks into basic worker motions, or Therbligs (so-named by the originator of time-study analysis, Frank B. Gilbreth). In an analogous fashion, this investigator has defined a set of basic teleoperator/industrial manipulator gripper movements, or Selwonks. Previously conducted research in the area of industrial robot end effectors by this researcher has been utilized to establish a set of standard gripper tasks.

Building upon this preliminary work, a prototype design has been undertaken for a fluid (hydraulic and/or pneumatic)-powered general purpose gripping mechanism which best satisfies a given set of Selwonks,

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WEAPONS AND SYSTEMS ENGINEERING DEPARTMENT

while tending to optimize simplicity, reliability, and cost. Emphasis is being given to developing the most versatile configuration with respect to suitability for the widest assortment of tasks. A prototype model of the gripper will be constructed. Easily available and relatively inexpensive fluidic logic devices (such as Clippard, Bimba, Visulogic, etc.) will be utilized where possible to minimize construction costs. It is hoped that a small five-rotational axis arm similar to those used on underwater research submersibles (such as ALVIN) can also be constructed to mount the gripper, thus allowing performance evaluation. Grade sensors (such as touch or proximity, and possibly slip) will be incorporated into the gripper with sufficient self-contained logic to enable a limited number of autonomous reflex maneuvers.

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RADAR SIMULATION STUDY

Researcher: Assistant Professor E. Eugene Mitchell

Sponsor: Naval Air Test Center

The purpose of this study was to develop a hybrid computer simulation of an M30, ground based tracking radar system which the Naval Air Test Center, Patuxent River, has on base. The radar is used for research purposes in conjunction with NATC projects.

The radar was fully instrumented and data was taken to record various internal signals. The data provides a means of verifying the simulation. Once proven, the simulation is to be used to study the effects of jamming.

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A DYNAMIC MODEL FOR THE FUEL CONTROL ON A GAS TURBINE ENGINE

Researcher: Assistant Professor Jerry W. Watts

Sponsor: David W. Taylor Naval Ship Research and Development Center, Annapolis Laboratory

The fuel flow rate in a gas turbine engine is a function of compressor discharge pressure (CDP), turbine inlet temperature (TIT), and rotational speed (NGG). The fuel control is a device which senses these parameters (CDP, TIT, NGG) and controls the fuel flow during accelerations and decelerations to provide fast but stable operation. Traditionally, fuel controls are hydro-mechanical devices which use fuel as the hydraulic fluid to operate servo valves and other hydraulic control devices necessary to control fuel flow into. With the advent

of microprocessors, electronic fuel controls are now being used. The electronics interface with the hydraulic and mechanical parts of fuel controls. Using electronics it is possible to provide acceleration/deceleration schedules, alterable at will, to control fuel flow. Of course, it would be desirable to obtain a dynamic model of a fuel control with enough flexibility so that it models both the traditional hydro-mechanical fuel controls and the newer electronic fuel controls. A dynamic model with this flexibility was written using FORTRAN. The dynamic model incorporates acceleration/deceleration schedules and the use of 6 adjustable parameters. The fuel control model is incorporated into a larger FORTRAN program called DYNOTE.

DYNOTE, written by T. Bowen and R. Muench, both of the David W. Taylor Naval Ship Research and Development Center, is a very flexible dynamic model of a gas turbine engine. The help of T. Bowen and R. Muench in developing the dynamic model of a fuel control is gratefully acknowledged.

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#### A STUDY TO DETERMINE AN OPTIMAL CONTROL STRATEGY FOR A MARINE VEHICLE SUBJECTED TO RANDOM DISTURBANCES

Researcher: Midshipman 1/C Dirk J. Debbink

Adviser: Assistant Professor Kenneth A. Knowles, Jr.

Sponsor: Trident Scholar Program

The specific problem investigated during this project, while extrapolatable to more general cases, involved the determination of the near optimal performance, with respect to speed through the water, of a sailcraft subjected to steady state and random wind and wave forces. The results of the research exceeded existing empirical techniques in that a method was developed for preparing, before hand, using a set of digital computer programs, an analytic near optimal performance package for any yacht possessing a valid International Offshore Racing (IOR) certificate. This package can be utilized to accurately predict the yacht's performance for any reasonable set of wind and wave conditions. Theoretical static and dynamic vessel stability was investigated for varying driving forces, wind force, heading, and righting forces, along with varying environmental conditions. A package of FORTRAN computer programs was developed to (1) solve the static optimization problem; (2) determine optimum sailing angles to windward for given vessel dimensions and wind and sea conditions; (3) calculate and plot complete true and apparent wind polar plots of vessel speed through the water in three dimensions for any arbitrary wind and sea history. Initial experimental verification of the performance package for the U.S. Naval Academy's fifty-eight foot Sparkman and Stevens design sloop SYREN has indicated close agreement between predicted and actual vessel performance.

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INDEPENDENT RESEARCHWEAPONS AND SYSTEMS ENGINEERING DEPARTMENT

## COMPUTER SIMULATION OF CARDIAC MUSCLE PERFORMANCE

Researcher: Lieutenant Thomas M. Judd, USN

One area of great interest in the last twenty years of cardiac research has been to find a description of mechanical performances of ventricular and atrial contraction which is appropriate for overall models of the circulatory system regulation. Experimental studies on heart muscle mechanics have been undertaken to find the simplest model which adequately describes the interrelation between instantaneous force  $F(t)$  and instantaneous length ( $L$ ) including their time derivatives. Of particular significance in this research has been the determination of  $F(t)$  and  $L(t)$  for the conditions as experienced by the myocardium in the physiologically-beating ventricular wall.

Loeffler and Sagawa analyzed the relation between instantaneous force  $F(t)$  and instantaneous length  $L(t)$  of excised cat papillary muscle in 1974. Their analysis dealt with the time-varying visco-elasticity of heart muscle. In isometrically-contracting papillary muscle was perturbed with extremely small length changes,  $L(s)$ , and muscle-force responses,  $F(s)$ , were measured as a function of both frequency and time after stimulation ( $s$  denoting Laplace transform). Based on time-dependent and frequency-dependent changes in stiffness parameter  $F(s)/L(s)$ , two alternative configurations of a heart muscle model were obtained. A unique feature of this model was that it was the first in which viscous elements of periodically resting and activated heart muscle were explicitly and quantitatively incorporated, based on experimental data. Most previous models had only implicitly incorporated the viscous property of active muscle in terms of Hill's force-velocity relation of contractile elements.

The present engineering analysis involved a computer simulation of the above model, first to validate the authors' experimental data for isometric contractions by small perturbations, and secondly, to examine the validity of the model for contractions involving large extents of shortening. This simulation involved an integrative prediction of the total muscle-force time relation. Seven out of eight parameters of the model were functions of muscle length. Two active branch parameters were non-linear functions of time while the third active branch parameter was a linear function of instantaneous muscle force.

A follow-up to the initial simulation included an examination of how the model which was derived from small-length perturbation analyses on isometric contraction relates itself to the muscle performance in other modes of contraction, i.e., isotonic (constant force) contraction.

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RESEARCH COURSE PROJECTS      WEAPONS AND SYSTEMS ENGINEERING DEPARTMENT

THE GOULD PRINTER/PLOTTER -PORTABLE AND TRANSPARENT FOR MINICOMPUTER USE

Researcher: Midshipman 3/C Marc M. Adkins

Adviser: Assistant Professor Charles G. Brockus

The purpose of this research was to make the Gould Printer/Plotter portable and transparent for minicomputer use.

The objectives were (1) to program the SDK-80 resident in the Gould Printer/Plotter to provide both print-mode and plot-mode capability for the device, and (2) to define the protocol under which the device communicates with a minicomputer in such a manner as to make its operation independent of the sending device.

Since the Intel 8080 is to be used as the hardware interface, its assembly language must become familiar. An eight-bit parallel input port will serve to accept data from the minicomputer, and special ASCII characters will signal the enabling of print mode or plot mode.

The buffering and processing needed to relieve the minicomputer of the burden of defining a plot point-by-point will be provided in the SDK-80.

Print mode has been completed, and plot mode is about 30% complete.

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ANALOG MUSIC SYNTHESIZER

Researcher: Midshipman 1/C William H. Millward

Adviser: Assistant Professor Charles G. Brockus

The purpose of this research was to develop a system for the analog synthesis of audio waveforms.

The objectives were to study various control and synthesis techniques, select the more attractive ones, and build and test circuitry for musical waveform production. The qualities needed include harmonic content and envelope generation for attack, sustaining, and decay.

After utilizing voltage-controlled devices in the realization of subtractive synthesis techniques to achieve the generation of waveforms with the required harmonic content and envelope qualities, noise was added for aesthetic purposes. Then, two interfaces were provided: a keyboard for manual actuation of the synthesizer, and a parallel data interface to a digital computer to permit random or stylized "composition" to be realized automatically.



RESEARCH COURSE PROJECTS      WEAPONS AND SYSTEMS ENGINEERING DEPARTMENT

The project was continued as a design project in ES402, in which the digital interface was completed. The project has reached successful completion.

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ADAPTING THE DEVICE INDEPENDENT GRAPHICS SYSTEM TO THE VT-11: DIGSVT

Researcher: Midshipman 2/C Samuel L. Park

Adviser: Assistant Professor Charles G. Brockus

The purpose of this research is to provide the software modules required to incorporate the VT-11 as a useful peripheral in the Device Independent Graphics System.

The objectives were to become familiar with the RT-11 operating system; to become familiar with the DIGS capabilities; to learn the specific characteristics of the VT-11; and, to integrate the foregoing knowledge in the preparation of the required software modules to produce DIGSVT.

The educational process of acquiring the information in the above areas is essential to permit the production of the software package goal, DIGSVT. While DIGS supports CRT's, picture system, and table input, the characteristics peculiar to the VT-11 require the software modules to be tailored for them.

Progress is continuing in the educational aspects of the project.

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A SYSTEMS APPROACH TO THE ISOLATION OF THE MECHANISM RESPONSIBLE FOR THE PEAK-SHIFT PHENOMENON AS OBSERVED IN INORGANIC CHEMICAL ANALYSIS DATA RETURNED FROM THE VIKING I MARS LANDAR

Researcher: Midshipman 1/C Richard A. Wall, Jr.

Adviser: Assistant Professor Charles G. Brockus

The purpose of this research was to determine an algorithm for the automatic correction of data retrieved from the Viking I Fluorescence Spectrometer to remove the peak-shift due to ambient temperature.

The objectives were to model the Proportional-Counter Tube in terms of the manner in which its operation is effected by variations in ambient temperature. From this model, an additional objective is to provide the algorithm necessary to correct the spectrometer data for the peak-shifts due to temperature variations.

Bench test data was used to provide the empirical tables of corrections for spectrometer data due to temperature. A model was proposed for the variations in the operation of the P-C tube with element under study; a mode/casing potential difference, and ambient temperature. This model was to provide the basis for an algorithm for the automatic peak-shift correction of spectrometer data.

Results were provided from the P-C tube model, but require correlation with the bench test data. A correction algorithm was proposed based on acceptance of the model performance.

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PUBLICATIONS

WEAPONS AND SYSTEMS ENGINEERING DEPARTMENT

BLUM, Joseph J., Lieutenant Colonel, USAF, "Changing Educational Goals At the United States Naval Academy: 80 Percent of All Midshipmen Must Select an Engineering or Science Major," Air University Review, 27(May-June 1977), 72-82.

The historical development of the present split of technical/non-technical major selection at the U.S. Naval Academy is traced, with special emphasis on those aspects which would be of particular interest to the 2142 men who elected to take their commission in the U.S. Air Force (USAF) during the years 1949 through 1968. The educational objectives which led to abandonment of the old so-called "lockstep" curriculum are reviewed, and the development of the minors options, and later the major-for-all program, is discussed. The current science-engineering program is examined, and one engineering major is discussed in detail.

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KNOWLES, Kenneth A., Assistant Professor, "The EAI MiniAC Analog/Hybrid Computer and a First Course on Systems Simulation." Proceedings of the 3rd Biennial Washington-Annapolis-Baltimore Area (WABA) Symposium on Computers in Education, U. S. Naval Academy, 18 May 1977.

The first course in systems simulation which is taken by the engineering systems majors at the U.S. Naval Academy is briefly described. Analog computer simulation comprises the first 60 percent of the course. The EAI MiniAC analog/hybrid computer is the specific machine used by the students for their simulation studies. The MiniAC is briefly described to provide some insight into its power and versatility. Four representative student simulation studies are then described to indicate the breadth and depth of the course. It is concluded that the power and versatility of the MiniAC computer greatly facilitated the broad scope of simulation problems which are studied in this first course on systems simulation.

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MITCHELL, E. Eugene, Jr., Assistant Professor, "Design of a Hardware Observer for Active Machine Tool Control," Proceedings of the 1976 Joint Automatic Control Conference (JACC), Purdue University, Lafayette, Indiana, 27-30 July 1976.

Observer theory is applied to design an active controller for a machine tool such as a lathe to reduce the chatter tendency and forced vibration effects that can be detrimental to a workpiece surface finish. An observer is used to estimate difficult to measure relative motion between the cutting tool and workpiece. The estimated motion is used in conjunction with measured states in a second application of observer theory to design a control system that causes the cutting tool to track the workpiece, negating relative vibratory motion. Hence, the entire

control system with the cutting tool position as an output is an observer of workpiece motion. Stability of the controlled system as a function of mismeasurements of dynamical parameters and its ability to reduce forced vibration effects are discussed. Performance calculations are based on a second-order machine tool-workpiece dynamical model; however, the presented methods of design and analysis can be extended to higher order systems.

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MITCHELL, E. Eugene, Jr., Assistant Professor, "Analog Simulation of a Guidance Gyro Including Nonlinearities." USNA Report No. EW 11-76, October 1976.

During the initial development of the 5-inch guided projectile, the Naval Weapons Laboratory, Dahlgren, was manufacturing the most precision gyro within their capability. They were holding extremely tight tolerances, tolerances that eliminated nine out of ten parts. They had estimated the gyro at \$50,000 a copy. This ultra precision was not required; however, many factors determine the precision of a gyro and the factors which were important to the 5-inch guided projectile could not be separated from the factors which were not important.

The purpose of this study was to simulate the gyro on the analog computer. The simulation was to include all nonlinearities, such as stiction, friction, non-orthogonality of the axis, rotor and gimbal mass unbalance, etc. The guidance group at Dahlgren would then study the effects of these deviations on the overall gyro performance and determine those which were important to the 5-inch guided projectile. The final objective was to reduce the tolerance to the minimum required and hence reduce the cost to an acceptable level.

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MITCHELL, E. Eugene, Jr., Assistant Professor, "Frequency Response Calculations With a Programmable Pocket Calculator," Simulation, 29(July 1977), 21-24.

Pocket calculators are here to stay. However, programmable calculators suffer from the problem of all computers: they are never quite big enough or never have quite enough room.

This paper describes an algorithm, that with the user's help, allows a small programmable calculator to compute frequency response values for a system containing a total of up to four poles and zeros. Most basic automatic controls courses work few, if any, frequency response problems larger than this.

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PUBLICATIONSWEAPONS AND SYSTEMS ENGINEERING DEPARTMENT

OLSEN, Charles F., Associate Professor, and Charles G. BROCKUS, Assistant Professor, "Digital Computation of Inverse Laplace Transform," Simulation, 29(December 1976), 197-202.

An algorithm is described for the digital computation of the inverse Laplace transform of a function containing multiple real or complex poles. The algorithm utilizes a simple mathematical technique to evaluate a polynomial and its derivatives at a root of the polynomial. This method allows the numerator and denominator polynomials of the function to be treated separately by dividing each repeatedly by a first order term.

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PRESENTATIONS

WEAPONS AND SYSTEMS ENGINEERING DEPARTMENT

KNOWLES, Kenneth A., Assistant Professor, "The EAI MiniAC Analog/Hybrid Computer and a First Course on Systems Simulation." Paper read at the 3rd Biennial Washington-Annapolis-Baltimore Area (WABA) Symposium on Computers in Education, U.S. Naval Academy, Annapolis, 18 May 1977.

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DIVISION OF  
ENGLISH AND HISTORY

## ENGLISH DEPARTMENT

Professor Michael Jasperson, Chairman

Academic Year 1976-1977 was an active one in the English Department for literary research and writing. Three sponsored projects were underway: the continuation of an extensive investigation of writers-in-residence in American colleges, a biographical and critical study of an important contemporary poet, and research into the nautical experiences and background of a major nineteenth-century American writer. Independent research, with seven separate investigations, included critical and bibliographical studies of American authors--Walt Whitman, Lillian Hellman, and Shirley Jackson--and analyses of works by Shakespeare and Horace. An officer instructor in the Department was preparing for publication a guide to professional writing for junior officers.

Eleven articles were published in scholarly journals and two articles were parts of collections in book form. Four papers were presented at meetings of professional societies.

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SPONSORED RESEARCH

ENGLISH DEPARTMENT

YET DOES HE MARVEL: A CRITICAL STUDY OF THE POETRY OF ROBERT HAYDEN

Researcher: Assistant Professor Fred M. Fetrow

Sponsor: Naval Academy Research Council

The objective of this project is the completion of a comprehensive critical study of the full canon of Robert Hayden's poetry. Such a study will make more accessible to students and scholars of contemporary American literature the works of an important and presently neglected poet. The results of this research should be publishable in several possible formats: as a monograph-length critical study, as a pamphlet-style introductory study of an individual author, or as a series of articles in analysis/explication of particular poems or groups of poems.

The present researcher is combining primary research (tracing and acquiring all of Hayden's work in various locales and formats), personal interviews with the poet (to obtain biographical detail which may be relevant), and textual analysis (after organizing and categorizing the poems with respect to chronology and subject matter).

The researcher has met with and exchanged correspondence with Mr. Hayden since March of this year; he has been most cooperative. In addition to helping locate early published volumes of his poetry, he has volunteered to send, before their publication in the fall, the poems he has written during his tenure as Poetry Consultant at the Library of Congress. With Hayden's help and the services of the reference librarians at Nimitz Library, all but a few of the poems are now analyzed. While classifying them, a thematic organizational principle for the study has evolved. Meanwhile an extensive article has been completed and submitted for publication on Hayden's most frequently reprinted poem, "Middle Passage." Its content will be summarized and incorporated into the full study.

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HERMAN MELVILLE'S WHALING YEARS

Researcher: Professor Wilson L. Heflin

Sponsor: Sabbatical Leave

The purpose of this study is to present the available facts of Herman Melville's three whaling voyages and the island interludes and relevant events of the fishery during the years when he was a whaler. It seeks to extend our knowledge of an important phase in the life of a major American writer and to provide a firmer basis for the criticism of his books.



Part I of this study sketches Melville's life up to December 25, 1840, when he shipped as a green hand aboard the Acushnet of Fairhaven, Massachusetts. Melville's brief experience as a merchant seaman in 1839 and the nautical careers of his cousins--in the Navy, the whale fishery, and the merchant marine--are emphasized.

Part II, "The Acushnet Outward-Bound," follows the maiden voyage of Melville's first whaler during the eighteen months of his apprenticeship in the whale fishery. Separate chapters give detailed accounts of the routine of duty on passage, on whaling grounds, and in recruiting ports. One chapter describes the hazards of whaling in 1841-1843.

Melville's brief tour of duty in the bark Lucy Ann of Sydney, Australia, and his part in a revolt at Tahiti are presented in Part IV of this study, which makes use of detailed consular papers in the Mitchell Library, Sydney, Australia.

Melville concluded his whaling years with a six-months' cruise, perhaps as a harpooner, in the ship Charles and Henry of Nantucket. This hitherto most obscure period of his whaling career is documented by newly discovered papers of the ship's owners and by consular and marine records in the National Archives.

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#### THE CREATIVE WRITER AND THE UNIVERSITY

Researcher: Assistant Professor Philip K. Jason

Sponsor: Naval Academy Research Council

This study will analyze the history and nature of writer-in-residence positions at American colleges and universities. Questions to be explored include the following: What social principles, governing both the writer and academe, lie behind the formalized relationship of the residency post? How has the acceptance of a residency helped (or hindered) the productivity of various writers? What specific advantages have colleges gained by maintaining such positions? One specific issue to be explored is the claim that there has been, since World War II, an "institutionalization" of the historically rebellious writer, with reductive effects on artistic output.

Three categories of research materials are being sought and examined. First of all, a comprehensive survey of secondary sources bearing upon the problem has been made. Published books and articles in literary history, biography and autobiography, correspondence, institutional history, and the sociology of literature have been located and examined. Particular attention has been paid to studies of university and foundation sponsorship of the arts.

Through the continuing use of a questionnaire, a survey of the contemporary scene is being developed. This survey will be carried forward and combined with a series of tape-recorded interviews with writers holding (or having held) residency posts.

The third research area involves the exploration of unpublished materials. Many significant holdings have been located, but few have been explored to date.

Basically, the investigation combines institutional history with comparative literary biography.

Research has progressed to the point of significant detail on the following topics: (1) The general background of writing as a profession with particular attention to the writer's means of support. (2) The history of art education in the United States. (3) The establishment of the first writer-in-residence post, held by Percy MacKaye, at Miami University (Ohio) in 1920. (4) The second such post held by Robert Frost at the University of Michigan beginning in 1921. (5) Controversy, particularly during the 1950s, on the benefits and drawbacks of the institutionalization of the writer in the university. (6) History of the residency position held consecutively by William Faulkner, Katherine Anne Porter, and Stephen Spender at the University of Virginia (1957-60).

An article manuscript, "The First Writers-in-Residence: MacKaye and Frost," is in circulation.

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## AN ANNOTATED BIBLIOGRAPHY OF LILLIAN HELLMAN

Researcher: Lieutenant Steven H. Bills, USN

The purpose of this project was to compile a comprehensive annotated bibliography on the life and works of Lillian Hellman. The project involved research done at the New York Library for the Dramatic Arts and the Library of Congress as well as at local libraries. The bibliography includes all works by Hellman, reviews of all New York and other principal openings of her plays, and over 300 articles about Hellman's life. The project has over 1000 citations, all annotated. The manuscript is in final preparation for publication. It will also be used as a master's thesis.

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## THE CHRISTIAN SOURCES OF SHIRLEY JACKSON'S "THE LOTTERY"

Researcher: Associate Professor John P. Boatman

Plausible though the current critical opinion is that Shirley Jackson's provocative short story "The Lottery" (1948) derives principally from both her inspiration of the moment and from her reading of Frazer's The Golden Bough (1913), the present researcher finds that Jackson has utilized two specific Christian sources as the basis of her story. The first is a passage in St. Augustine's On Christian Doctrine that describes an appalling tradition in Gaul that impels one village to divide its membership into two groups annually and then proceed to stone each other, friends and relatives alike, until a death occurs. The second source is a passage in the book of Joshua that outlines the method by which Achan, the transgressor, is chosen by lot for punishment by communal stoning. This method Jackson adopts in her story, even to several terms of the original. With this knowledge of sources, it is possible to read Jackson's story as a bleak and tragic parable on the suicidal tendencies of modern Christian society rather than merely a wry comment on the disturbing recrudescence of primitive rites in an unreflecting and obtuse society.

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## THE HERALDRY OF LANCELOT'S SHIELD IN TENNYSON'S "THE LADY OF SHALOTT"

Researcher: Associate Professor John P. Boatman

Tennyson gives Lancelot in his early poem "The Lady of Shalott" a shield device which he describes as "A red-cross knight [who] for ever knee'ld/To a lady in his shield,/That sparkled on the yellow field./Beside remote Shallott." Critics have either ignored the device, associating it with Lancelot's son, the Grail Knight Galahad, or saw it as mere decoration. The present researcher finds that the heraldic

device is not wholly Tennyson's invention, that it derives first of all from the same shield device given to Lancelot as a disguise by Malory in *Morte d' Arthur* (Book XII), that the device is properly assigned to Lancelot, not to Galahad, because "Galahad" was Lancelot's birth name, that it may be read by heraldic lore and tradition as a display of Lancelot's compromised moral character because of his illicit liaison with Queen Guinivere, that we must reread the poem as Tennyson's comment on the survival value of compromise in a realistic world rather than solely as a tragedy of effete idealism, isolated from the real life of everyday concerns.

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## THE JUNIOR NAVAL OFFICER'S GUIDE TO PROFESSIONAL WRITING

Researcher: Lieutenant William J. Sabo, USN

The Junior Naval Officer's Guide to Professional Writing will differ from the ordinary writer's handbook in that it will be tailored specifically for the naval officer. Though it will stress fundamentals applicable to all formal writing, it will illustrate writing principles in the context of the kinds of written communication constantly confronting the junior officer, and it will address writing problems peculiar to naval communication. Among other things, this book will instruct the officer in writing an officer fitness report, an enlisted evaluation, a letter of recommendation, a wardroom brief, a legal investigation, a formal report, a memorandum, and a letter to one's detailer. The Junior Naval Officer's Guide to Professional Writing will attempt to impress upon the junior officer that writing is not merely an incidental aspect of his job, but a vital and indispensable part of his profession, and for that reason the officer should strive to be as professional a writer as he is a navigator, a shiphandler, or an engineer.

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## THE SHIP AND ITS RELATED IMAGERY IN "INSCRIPTIONS" AND "SONG OF MYSELF"

Researcher: Lieutenant William J. Sabo, USN

Like many men of his day, Walt Whitman was fascinated by the beauty and grace of the sailing vessel. During his boyhood on Long Island he had seen the New York harbor bustling with sailing craft of all kinds, a sight which he later recalled as his first reason for writing poetry: "The first time I ever wanted to make anything enduring was when I saw a ship under full sail and had the desire to describe it directly as it seemed to me." Gay Wilson Allen points out that even later in Whitman's life, when he was in New York on business, "He indulged in his usual amusements. . . on the water surrounding Long Island....He wrote his



brother about watching the yachts practice for a race scheduled to begin on Monday. He thought the AMERICA the 'handsomest craft' he had ever laid eyes on." This alluring impression of the ship was so irrevocably a part of the poet that it naturally became part of Leaves of Grass, too.

Scholars have debated the meaning and function of the sea in Whitman's poetry, but surprisingly few have noted the significance of his use of the ship and its related imagery. Like Ezra Pound, Whitman believed that imagery in itself does not make poetry; it must be functional, as he believed all his poetry to be. The purpose of this essay is to show that the ship and its associated imagery function in various ways to unify "Inscriptions" and "Song of Myself."

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#### HORACE: ODES, IV, 7--THE EVOLUTION OF A TRANSLATION

Researcher: Professor John N. Wysong

Translation problems in poetry are often best met by other poets. A case in point is the much admired Housman translation of Horace: Odes, IV, 7. Since this is one of Horace's most popular poems, it has been translated in English many times. Most of these translations are failures. Most of the failures have been done by professional translators, critics, and pedagogues. One of the few decent ones was done by a respectable, if not a great, poet, Dr. Samuel Johnson. The main reason it takes a poet to translate a poet is that only he has that feeling for the proper diction that is necessary if the effort is going to be at all successful.

As good as the Johnson translation is it pales beside the A.E. Housman version which is characterized by Housman's trademarks: economy, precision, and a feel for exactly the right word.

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#### SHAKESPEARE'S USE OF MYTHOLOGY IN THE WINTER'S TALE

Researcher: Professor John N. Wysong

Far from being considered one of Shakespeare's failures because of alleged structural failure, The Winter's Tale is now judged by critics and scholars to be one of the poet's masterpieces.

The aging playwright evidently chose to emphasize the final stage of the complete tragic pattern for his last plays. The pattern is as follows: prosperity-destruction-rebirth. The great tragedies of Shakespeare's middle period naturally emphasize only the first two parts of this equation. It seems that having purged the violence and



despair out of his system by the writing of these tragedies, he then turned to the more satisfying recreative aspect of the third stage of the pattern. Of the four romances The Winter's Tale best illustrates the poet's creative imagination at work in this area. What makes this play particularly rich is that Shakespeare links this pattern to the cycle of the seasons and by doing this is able to tap one of the most important of the Greek myths, the Demeter-Persephone myth. Thus we have prosperity(summer) followed by destruction(winter) followed in turn by rebirth(spring). Spring(Persephone) is symbolized in the play by Perdita, the lost and refound daughter of King Leontes. Her return is linked to the coming of spring and to the passing of winter(Leontes' sixteen years of grief and penance). And her marriage to Prince Florizel leaves us happy in the knowledge that life will continue.

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ARNOLD, James A., Associate Professor, "The Young Russian's Book in Conrad's 'Heart of Darkness,'" Conradiana, VIII (1976), 121-126.

The seamanship book found by Marlow in a hut on the Congo and returned to a young Russian at the Inner Station in Conrad's "Heart of Darkness" is almost certainly Nicholas Timmouth's An Inquiry Relative to Various Important Points of Seamanship, Considered as a Branch of Practical Science, London: Joseph Masters, 1841. No book by anyone names Tower, Towson, or Towser--the names given to the author by Marlow--with a title related to the subject matter of the Russian's book as described by Marlow seems ever to have been published in England. In substituting the name Towson for Timmouth, Conrad probably had in mind John Thomas Towson, author of three important navigation books published in the mid-Nineteenth Century. The printed short title of Timmouth's book, An Inquiry Relative to Various Important Points of Seamanship, is close to Marlow's title "An Inquiry Into Some Points of Seamanship." Timmouth's book was published only 15 years after the Russian's, a time discrepancy not uncharacteristic of Conrad. Timmouth was Master Attendant of her Majesty's Dock-Yard at Woolwich, not a "Master in his Majesty's Navy," as Marlow calls Towson, but Conrad may have preferred the more distinguished title. All these discrepancies may be due to Conrad's faulty memory but more probably are deliberate obfuscation. Conrad probably changed the author's name to avoid the incredibility of the real name Timmouth and its derogatory connotation (tin mouth), to display Marlow's characteristic vague memory for names, and to inject the humorous tone of the collocation Tower, Towson, Towser (a dog's name). The personality Timmouth displays in his book is very much the same as that of Towson as inferred by Marlow, and the contents of his book are identical to those of Towson's book as described by Marlow. No other similar book seems to have existed.

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FETROW, Fred M., Assistant Professor, "Better Write Than Righteous," Getting It on Paper: Materials From a Conference on Student Literacy. Towson State University, 1-2 October 1976, pp. 28-38.

One reason high school and college students write poorly is because they minimize the value of composition as a practical skill. Teachers and administrators can raise both student priorities and verbal competence by stressing pragmatic teaching and application of writing skills. One technique for such teaching would emphasize purpose and audience, rather than the student-writer's self-gratification. In effect, the "writing self" would become subordinate to the "editing self," and the teacher would set the example through close reading, careful editing and copious critiques of student writing. Such an individualized approach requires a commitment to composition by teachers and administrators; when that commitment is discerned by students, perhaps their priorities will change and their writing will improve accordingly.

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FETROW, Fred M., Assistant Professor, "Strata and Structure: A Reading of Shakespeare's Sonnet 73," Concerning Poetry (December, 1976), 23-25.

While the "standard" interpretation of Shakespeare's Sonnet 73, that the speaker is pleading for increased love in the face of imminent death, accommodates the placement of Sonnet 73 in the sequence, the structure of the sonnet itself suggests another possible reading. A close analysis of this structure shows that diverse elements of the poem combine to point to another message. These elements culminate in line twelve with a cryptic statement on the narrowing disparity between youth and old age, which when thus considered, renders the couplet less ambiguous, and hence, suggests the overall sonnet is more objective and more profound than has been indicated by previous interpretation.

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FETROW, Fred M., Assistant Professor, "Swift's Gulliver's Travels," The Explicator, 35 (Spring, 1977), 29-31.

When one inventories the nature and number of souvenirs collected by Gulliver on each of his four voyages, one perceives how Jonathan Swift makes explicit the diminution in Gulliver's self-awareness and moral stature. Gulliver becomes progressively more prideful and less humane; the items he chooses to keep as mementoes change accordingly until by Book Four, he brings back nothing except the skins of his own species, valued only for their utility. Through this pattern, Swift amplifies his characterization of Gulliver by symbolically saying, "By his souvenirs, so shall you know him."

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HEFLIN, Wilson L., Professor, "Herman Melville: Seaman and Author," in Sea Fiction Guide, by Myron J. Smith, Jr. and Robert C. Weller. Metuchen, New Jersey: The Scarecrow Press, Inc., 1976, xx-xxii.

This introductory essay begins with a sketch of the nautical career of Herman Melville--as merchant seaman, whaleman, and ordinary seaman in the United States Navy--an extensive and varied maritime experience which made it possible for him to write with authority about the sea.

In Melville's early books the land is dominant. A ship brings the narrator to a savage island or a civilized port, and, after many adventures, his own or another ship takes him away. But there is a clear progression in his fiction toward landlessness, until the Pequod of Moby-Dick, leaving Nantucket, sails on and on toward its destruction with never a stop ashore.

In "The Lee Shore" chapter of Moby-Dick, Melville wrote that "in landlessness alone resides the highest truth, shoreless, indefinite as God...." As Melville developed as an author, the ship increasingly became a microcosm of the world, and the events on board reflected the universal problems of mankind.

Melville's greatest sea stories are engaging and exciting on the simple level of narrative. But in each of them there is a "lower layer," a courageous symbolic effort to comprehend the universe and the roles of mankind in it.

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HEFLIN, Wilson L, Professor, "Melville, Celestial Navigation, and Dead Reckoning," Melville Society Extracts, No. 29 (January, 1977), 3.

We seldom think of Herman Melville as a failed civil engineer or an unfulfilled navigator. Yet he was well-trained for both callings at the Lansingburgh Academy. He learned the theoretical basis of navigation from Jeremiah Day's The Mathematical Principles of Navigation and Surveying. He also learned from Day's text the practical use of navigational instruments: the mariner's compass, Hadley's quadrant, and the log-line.

In his writings Melville used navigational incidents and navigational reference here and there--the comic lunar observation in Omoo, "Chronometricals and Horologicals" in Pierre, the deviated compasses in "The Admiral of the White"--but never in such detail or with such symbolic intent as in Moby-Dick.

When Captain Ahab defies the sun by petulantly destroying his quadrant and proclaiming that he will navigate the Pequod by compass and log-line alone, he incurs a grievous navigational loss. In the typhoon which strikes the ship, she is "but a tossed shuttle-cock to the blast," and the lightning reverses the polarity of the ship's compasses. Ahab improvises a compass with a sailmaker's needle but does not trouble to test the new compass' accuracy in terms of variation and deviation. When the log-line, so long unused, is heaved, the sea parts it, and Ahab orders the construction of a new chip and the mending of the line.

Melville's getting Ahab into extreme navigational difficulties and then failing to do anything further about them raise certain large critical questions. Did Melville, knowledgeable as he was in navigational matters, choose at this point in his narrative to forget his compositional premises or refuse to be diverted by side-roads from his larger intent? Or was it predestined that the fated Pequod should unerringly and without serious incident hold her course to the Equator and learn there of the nearness of the White Whale?

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HEFLIN, Wilson L., Professor, "Naval Slang," Dictionary of American History. Revised Edition. New York: Charles Scribner's Sons, 1976. Vol. VI, pp. 301-302.

The slang of American naval officers and enlisted men must be distinguished from the technical jargon of the U.S. Navy. The purpose of this jargon is serious and precise communication; navy slang, on the other hand, is usually disposed to be jesting and often deliberately obfuscates meaning. A naval slang term is most frequently a nickname for an authorized term, a salty variant for an accepted word or expression. American naval slang is usually different from that of other seafarers, such as merchantmen and whalemens. A distinguishing characteristic of American naval slang is that it is often long-lived, whereas general slang is usually soon worn-out with overuse. Naval slang belongs to an oral tradition. Printed records of it from the remote past are found chiefly in long-forgotten man-of-war narratives by enlisted men and in a few books by established American writers, such as Herman Melville's White-Jacket (1850).

American naval slang in the nineteenth-century was largely derivative, based to a considerable extent on British locutions. During World War I and, especially World War II, our naval slang became an extensive colloquial language, original, vigorous and expressive.

The U.S. Naval Academy is the source of a substantial slang vocabulary, which midshipmen acquire while in school and take with them after graduation to new duty stations afloat and ashore. Much of this slang, as printed in the annual handbook Reef Points, seems fresh, humorous, and singularly inventive to each incoming class of "mids," but part of this service-slang is ancient and traditional, with some expressions recorded in 1898 still in active use in the 1970's.

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JASON, Philip K., Assistant Professor, "A Possible Allusion in Thomas Hardy's 'Going and Staying,'" Victorian Poetry, 14 (Autumn 1976), 261-263.

The third and last stanza of Hardy's "Going and Staying" reveals time as a destructive force indifferent to human values:

Then we looked closer at Time,  
And saw his ghostly arms revolving  
To sweep off woeful things with prime,  
Things sinister with things sublime  
Alike dissolving.

This image of time, with its revolving arms, may be an allusion to Hamlet's Mill, that mysterious instrument of remote legend that has a direct connection to time and to heavenly dispensation. The mill



is treated in various northern legends with which Hardy was familiar. In all of its versions, the heavenly mill produces periods of time: world ages. In Greek mythology it is a constellation under the domain of Chronos. This image, in which Time and Destruction are functions of one another, fits perfectly the intent of Hardy's stanza. The mill of time lies behind all change and contract, including the separation of heaven and earth. Signaling an ancient outlook whose determinism is in keeping with Hardy's own, this allusion to Hamlet's Mill appropriately concludes a poem which argues that Fate is neither beneficent nor antagonistic toward man--simply and profoundly indifferent.

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JASON, Philip K., Assistant Professor, "Throw Away Your Hemingway Code-book," Indirections, 1 (Spring-Summer 1976), 59-64.

A good deal of Hemingway criticism purports to discover a prescribed code of behavior in that writer's works. An alternative view discerns Hemingway's interest in man's need to order experience and argues that Hemingway's descriptions of tightly patterned behavior are just that--descriptions. These patterns, whether voluntary or involuntary, are best understood as survival mechanisms. Hemingway does not prescribe a code of conduct, rather he uses metaphors of rules, systems, and games to describe our shared need for illusions of order, our pains of disillusionment, and our struggles toward reorientation and balance. Hemingway has not fashioned a code to illustrate how we should behave. He has fashioned a set of literary devices to show us how we do behave and how we must behave if we are to survive in a valueless world. From this perspective, Hemingway's protagonists are not to be understood as exemplary figures, but as our representatives.

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SMITH, Charles W., Assistant Professor. "The Brownings and Sir John Bowring: A Truncated Relationship," Studies in Browning and His Circle, 4 (Fall 1976), 85-88.

Sir John Bowring (1792-1872) and Robert Browning (1812-1889) seem to have met only once during their lives--in 1861 when Bowring visited Mrs. Browning in Rome just a few months prior to her death. The irony of the visit, however, lay in the fact that the two men had been linked in a scathing review of Browning's first play, Strafford: An Historical Tragedy, 1837. At that time Browning was relatively unknown while Bowring was a famous and somewhat controversial ex-legislator and translator of East European poetry into English. The review mocked Browning's play by suggesting that Bowring was going to translate it into English, the language in which it was, of course, written. When Browning returned to England after Mrs. Browning's death, he became something of a social lion and thus might have been expected to come into contact with Bowring again. However, the two

men seem neither to have met again nor to have corresponded, this conclusion being based on the fact that Bowring does not mention Browning in his posthumous Autobiographical Recollections of Sir John Bowring, which was published by Bowring's son Lewin in 1877. Apparently Bowring's literary interests encompassed only writers of the earlier nineteenth century. Browning was too new to interest Bowring. And Bowring, a Utilitarian, and biographer of Jeremy Bentham, was too prosaic to interest Browning.

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SMITH, Charles W., Assistant Professor, "Teaching Paul Gallico's 'The Enchanted Doll,'" The CEA Forum, 7 (April 1977), 4-5.

Beginning students of literature often prefer the weaker of two paired stories. From Laurence Perrine's popular textbook Story and Structure they prefer, for example, McKnight Malmar's "The Storm" to Faulkner's "That Evening Sun" and Paul Gallico's "The Enchanted Doll" to Isaac Bashevis Singer's "The Spinoza of Market Street." Gallico's carelessness as a craftsman plays into the teacher's hands. By committing a rather crude error in the time scheme of his story, Gallico allows the teacher to make the point that crudeness in execution often accompanies shallowness of conception. Although students are often distressingly sentimental, they are also rather logical. And despite the fact that they commit many errors in their own writing, they expect published material to be perfect. Therefore, being able to point out an error in execution can help the teacher make his point. At the same time, however, the teacher must insist that an otherwise admirable story that contains an error of this type is not necessarily ruined. It is the totality that counts. "The Enchanted Doll" is ruined by its complete and unremitting sentimentality. The time error is simply a bonus for the attentive reader.

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SMITH, Charles W., Assistant Professor, "Rebuttal," CEA Critic, 39 (May 1977), 9-11.

Professor Carol Simpson Stern, in her reply (CEA Critic, 39 [May 1977], 4-8) to my article entitled "A Flaw in Katherine Anne Porter's 'Theft': The Teacher Taught" (CEA Critic, 38 [January 1976], 19-21) argues essentially that (1) Miss Porter never made mistakes; (2) the point of view in "Theft" is highly complex; and (3) the ambiguity in the story's first paragraph is intentional and necessary to the story's complexity--all conclusions which I reject. I argue that there is no real "interior monologue" in the story, and that the protagonist is not self-deceived in her belief that her janitress has stolen her purse. Since the protagonist is a woman whose cold clarity of vision has ruined her, the first sentence should communicate that clarity, not deny it. In fact, Porter's last sentence suggests a more appropriate

opening for the story, one that uses the protagonist's actual words without quotation marks, just as the concluding paragraph does. Porter might have begun: "I had that purse [or "it"] when I came in, she thought. Standing in the middle of the floor. . . she surveyed the immediate past and remembered everything clearly." Such a beginning would both eliminate the tense confusion and, coupled with the concluding sentence, provide an appropriate framework for what lies in between.

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SMITH, Charles W., Assistant Professor, "Seventeen Guns for the Baron: A New Description of Lord Byron's Visit to the Constitution," Keats-Shelley Memorial Bulletin 27 (June 1977).

The purpose of this study is to reveal new information about the visit of George Gordon Byron, the Sixth Lord Byron, to the United States' ships Constitution and Ontario on May 21, 1922, in Leghorn Roads, Italy. The standard account of the visit is that by George Bancroft, the distinguished historian and Secretary of the United States Navy, in an essay entitled "A Day With Lord Byron," in History of the Battle of Lake Erie, and Miscellaneous Papers (New York: Robert Bonner's Sons, 1891), pages 191-210. A letter from another witness, Lieutenant John Needles Hambleton, USN, which has been recently discovered in the Library of Congress, disagrees with Bancroft in some particulars, most importantly over whether or not the 17-gun salute that was fired from the Ontario in Byron's honor should have been fired at all and, if so, whether it should not have been fired from the Constitution, the flagship of the Mediterranean fleet. An examination of the naval regulations then in effect in the United States and Great Britain reveals that Byron did indeed deserve a salute, that the salute properly came from the Ontario, the last ship Byron visited in the fleet, but that the salute should have been only 13 guns. The conclusion is that American ships of that day--at least the ships of the Mediterranean squadron--routinely fired 17 guns in honor of all visiting foreign dignitaries rather than try to consult the naval regulations of many different countries to find the exact number of guns required for each rank of dignitary.

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PRESENTATIONS

ENGLISH DEPARTMENT

FETROW, Fred M., Assistant Professor, "Better Right Than Righteous."  
Paper read at "Getting It on Paper: A Conference on Student Literacy."  
Towson State University, 2-3 October 1976. (See Publications, English  
Department.)

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HILL, John M., "Alchemy and Rhetoric in The Canon's Yeoman's Tale."  
Paper read at special session, "Alchemy and Literature," of the  
Modern Language Association, New York City, 27 December 1976.

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HEFLIN, Wilson L., Professor, "Melville, Celestial Navigation, and  
Dead Reckoning." Paper read at annual meeting of the Melville  
Society, New York City, 28 December 1976. (See Publications,  
English Department.)

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WYSONG, John N., Professor, "Shakespeare's Use of Myth in The Winter's  
Tale." Paper read at Conference of the Comparative Literature Circle  
of Florida State University, Tallahassee, Florida, 28 January 1977.

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## HISTORY DEPARTMENT

Associate Professor L. V. Thompson, Chairman

The History Department's research effort was extremely successful in 1976-1977. The Department greatly exceeded its past publication rate of a book per year. Four books were published in 1976-1977 which dealt with topics as diverse as sport history, local history, civil war naval operations, and naval biography. Two other volumes, both by the same author, have been accepted for publication and are currently in press. Additionally, four manuscripts have recently been accepted for publication this coming year. A basic revision of the textbook currently used in Naval History is underway involving five staff members, while three others have completed chapter contributions to a thematic volume of essays which surveys the history of the American Navy.

Ten articles covering a variety of topics were published by members of the History Department during the year. Article publication in the future will continue at a brisk pace as several staff members are nearing completion of the independent or sponsored research projects summarized on the following pages or listed in previous editions of the Summary of Research Activities. Naval history continues to be the principal publication and research focus within the Department, with research also occurring in the fields of American, European, and Asian History.

Three staff members received Naval Academy Research Council support for research on the colonial navies in the American Revolution and Naval strategy and decision-making during World War II. The breadth of scholarly activity and professional accomplishment within the Department is best demonstrated, however, by the large number of papers presented at professional meetings. Staff members delivered fourteen papers this past year. Moreover, History Department faculty members served as chairmen or commentators for eight programs within scholarly conferences held throughout the United States.

In sum, the History Department is heavily involved in research which is reflected in the enrichment of the classroom experience as well as considerable numbers of scholarly publications and professional papers.

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THE AMERICAN NAVIES IN THE AMERICAN REVOLUTION

Researcher: Assistant Professor James C. Bradford

Sponsor: Naval Academy Research Council

This project will produce a monograph on the American navies during the Revolution. Original research is focused on the establishment of the navies (state and continental), the one major institution for which Americans had no colonial model; the uses to which the navy was put; and the degree of success reached in achieving its goals.

Work was completed on operational phases of the war and begun on the navies' administration. Work was completed on Virginia and Pennsylvania navies but continues on other state and the continental navies.

The basic method employed is the examination of primary and secondary sources, the analysis thereof, and a report in monograph form of the conclusions drawn.

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MANNING THE NEW NAVY

Researcher: Assistant Professor Frederick S. Harrod

Sponsor: Naval Academy Research Council

When the United States emerged as a major naval power after the Spanish-American War, its new steel warships were visible proof of the changed nature of the navy. Equally important but less obvious was the transformation of the enlisted personnel system. Because the manpower practices of the sailing navy could not provide the large numbers of men and the technicians the new fleet demanded, established methods of recruiting and treatment of sailors had to be altered. In the process, the navy developed the foundations of its modern personnel system

The nineteenth-century service had filled its crews with professional mariners recruited from coastal cities of the United States and in the ports of the world. These men knew seafaring traditions and required little or no training before shipboard assignment. Sailors rather than navymen, they moved freely between the navy and the merchant marine.

The old personnel system persisted as long as the navy's need for men remained small. The enlarged requirements of the twentieth-century fleet meant the navy had to seek other sources of manpower.

Instead of relying solely on coastal areas, the department began enlisting men from inland regions of the United States, simultaneously developing a nationwide recruiting service and modern advertising techniques to attract men without maritime backgrounds.

Because most of the new recruits were landsmen, for the first time the navy had to provide comprehensive basic training for all new enlistees. It also instituted trade schools and technical courses to prepare men to operate the equipment aboard modern warships. The creation of this extensive training system meant that the navy had become a major educational institution.

Having invested considerable effort and expense in the recruiting and training of bluejackets, the Department also sought to encourage men to remain in the navy by improving the conditions of service. Among other measures, it adopted a retirement program, provided recreational facilities, and upgraded shipboard habitability.

These new policies of recruiting, training, and treatment changed the type of men in the service. The modern navy boasted that its sailors represented respectable families from the heartland of America. As the Department was able to enlist the men it desired, it also began to exclude or restrict aliens and blacks--groups that had formed an important part of the old navy. Yet the modern navy could discriminate against classes of men it disliked only because its personnel system succeeded in providing all the men its increasingly large and sophisticated ships required.

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#### THE POLICIES OF REAR ADMIRAL ERNEST J. KING AS CHIEF OF THE BUREAU OF AERONAUTICS

Researcher: Assistant Professor Robert W. Love, Jr.

Sponsor: Naval Academy Research Council

The purpose of the study is (1) to examine several issues over which Rear Admiral Ernest J. King was forced to modify his long-held views, and (2) to compare the broader bureaucratic implications of the American configuration for control of aviation policy with those of the configurations adopted by the British to discern latent incentives or disincentives in one or another regarding the exploitation of the new technology. The former concerned the clash between the Bureau of Navigation and the Bureau of Aeronautics over the assignment of naval observers and aviators, the dispute between the Bureau of Aeronautics and the General Board over naval aviation's share of appropriations during a period of mildly expanded funding, and the command role of the BuAer. The latter purpose is to test

the traditional interpretation that the independence of the Royal Air Force and its authority over British naval aviation during the Disarmament Era hampered British exploitation of naval aviation for military uses.

To date, the following matters have been addressed: (1) King's relations with the House Naval Affairs Committee; (2) funding levels for the Navy Department in the early years of the New Deal--which suggest, by adjusted comparisons with the Hoover Presidency, that President Roosevelt was hardly the enthusiast for naval building programs usually assumed; (3) King's relationships with other flag officers--especially Leahy--for it is evident that the two worked in tandem on many key issues; and (4) the broad comparison of American decisions regarding military organization in the Disarmament Era with those of the British--which suggests that the traditional interpretation at least fails to consider such variables as budgetary constraints, politico-military interfacing, and strategic assumptions which may explain the loss of Britain's early lead in naval aviation.

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## U. S. NAVY CARRIERS IN PHILIPPINE WATERS, OCTOBER 1944-JANUARY 1945

Researcher: Professor William M. Belote

The project is designed to result in a book-length manuscript that will present, for the enlightenment of the professional reader, an analysis of carrier operations as practiced from October 1944 to January 1945. The principal objective is to produce a book suited to assignment as collateral reading in Naval/military courses in order to acquaint youthful readers with the successes of the U.S. Navy during World War II. The book should generate interest among naval historians, especially as it concerns naval aviation. Research in archives and libraries is underway and source materials are being collected.

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## THE ROLE OF THE ROYAL NAVY DURING THE TEA CRISIS, 1773

Researcher: Associate Professor William L. Calderhead

Professor John Shy in an excellent monograph, Toward Lexington, has analyzed the position of the British Army in the crisis years just prior to the American Revolution, but a complementary study has never been presented regarding the Royal Navy. In providing such a study, this researcher has examined the mission of the Royal Navy in the Tea crisis in Boston in the fall of 1773. Diaries, newspapers, copies of personal letters, and official correspondence between the Admiralty and commanding officers on the American station have been examined. Evidence points strongly to serious negligence on the part of the Royal naval forces in Boston for allowing the crisis to develop as it did. A major feature of this negligence was a failure of command. If there had been better conditions of command, there is a good possibility that the tea party could have been avoided, and, although the Revolution would probably have taken place sooner or later, it would not have begun in Massachusetts or under quite the circumstances as actually occurred.

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## CRUSADERS AND OPPORTUNISTS: NORTHWEST EUROPEAN VOLUNTEERS IN THE WAFFEN-SS 1940-1945

Researcher: Captain Kenneth W. Estes, USMC

The participation by foreign nationals in the service of the German forces (Wehrmacht) in the Second World War has evoked both curiosity and consternation during and since that event. Pro-German observers saw in it evidence of a great pan-European movement against a Bolshevik danger, forging a new continental federation, led by the German Third Reich, which would replace the former nation-

states. Many idealists persuaded themselves that the rapidity of the German conquest of Western Europe proved the vitality of the Nazi way and the concomitant collapse of Democracy. Others dismissed the volunteer phenomenon as collaboration of the basest sort, for which the participants would pay stiff penalties when events showed they had backed the wrong side.

This study attempts to identify the key elements in the history of the West European volunteers in the German military by detailing some of the experiences of the volunteers recruited in three nations of Northwest Europe--Norway, Denmark, and Holland--during the 1939-45 War. In it, the largest group served on ground combat duty with the Waffen Schutzstaffel (Armed Protection Echelon) by virtue of their "Nordic" affiliation in the Nazi hierarchy of values. By studying these particular recruits, one may possibly learn something of the character of their military collaboration, of German attitudes toward them, and the value this movement contributed to the overall German war effort and particularly the Waffen SS.

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## AMERICAN FOREIGN POLICY: A HISTORY

Researcher: Assistant Professor Kenneth J. Hagan

This book is a history of American foreign policy from colonial times to the present. The dominant theme is the expansionistic nature of the American experience. Each of the fifteen chapters opens with a dramatic "diplomatic crossroad," illustrating the prevalent major and minor themes of the chronological period treated in the chapter. For example, Theodore Roosevelt's taking of Panama in 1903 set the stage for American political, military, and economic intrusion into the Caribbean Sea and Central America. Following presentation of the "diplomatic crossroad" is an analytical section explaining the mechanics and personalities of policymaking during the period covered by the chapter. The rest of each chapter is a narrative account concluding with an explanation of the legacy bequeathed by the policy-makers of that period to their successors. The book is intended as a text for upper division courses in American diplomatic history.

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APPLICATIONS OF JOHN RAWLS' A THEORY OF JUSTICE

Researcher: Associate Professor David E. Johnson

Rawls' A Theory of Justice has been one of the most widely-hailed volumes in several decades of British-American philosophy. It re-opens issues about justifying the structure and practices of social institutions. He attacks the dominant utilitarian approach to



justification, and argues for a variant of the social contract theory. In particular, he focuses on how to justify a social structure which provides its members with liberty and with equal amounts of the primary goods of this life.

This research involves reading both Rawls and the critical literature on Rawls, to try to understand precisely what Rawls is arguing for. Then his ethical theory will be applied to the institutions of education, possibly focusing on the concept of honor as a vehicle for explicating and evaluating what Rawls is doing.

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#### AN ANTHOLOGY ON EVOLUTION AND EDUCATION

Researcher: Associate Professor David E. Johnson

Criticisms of public and higher education have been made, and generally ignored, since at least the time of Thorstein Veblen. The focus of many criticisms has been that students lack motivation for and fail to see the point of their schooling. A recent study, Evolution and Education by Michael J. Grady of the University of Maryland, has suggested that one major source of this problem is that the organization of the schools runs counter to the evolution of the human brain. The uniquely human parts of the brain seem, on the basis of recent evidence, to be able to initiate activity and evaluate the results of that activity. Many classrooms function such that initiating and evaluating activity are the teacher's responsibility, not the students'. Therefore, the uniquely human capacities of the students' brains are not developed to the extent that they could be.

The purpose of this project is to search out and compile articles and parts of books dealing with physical and biological evolution, and the implications of the theory of evolution for educational practice.

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#### THE CONTROVERSY BETWEEN THE FEDERALISTS AND THE REPUBLICANS OVER THE RESTORATION OF THE BERCEAU TO FRANCE IN 1801

Researcher: Associate Professor Arthur A. Richmond, III

The purpose of this project is to investigate the controversy between the Federalist opposition and the newly installed Republic administration of Thomas Jefferson over the restoration of the corvette Berceau to the French government following the Quasi-War of 1798-1800 between France and the United States. The case of the Berceau appears to have presented the Federalists, recently defeated in the elections

of 1800, an opportunity by which they hoped to discredit the new Republican administration by charging it with misconduct.

Investigation has been carried out by research in American newspapers of the time, in the papers of individuals involved in branches of the American government, and in material from the archives of the French Ministry of Foreign Affairs. The material gleaned from this research is in the process of digestion, collation, and incorporation into an article.

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#### THE GENERAL STAFF AND THE DEVELOPMENT OF MODERN MILITARY ORGANIZATION

Researcher: Assistant Professor William R. Roberts

This dissertation is a comparison of American military and naval organizational values in the nineteenth century. The author intends through this comparison to determine why the U. S. Army adopted the concept of a general staff in 1903, as opposed to the Navy's rejection of a general staff in favor of a Chief of Naval Operations. The conclusions reached in this study should be helpful to the analysis and understanding of military institutions in general and should provide a clearer understanding of the process of organizational innovation in a military environment.

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#### THE UNITED STATES NAVAL ACADEMY: AN ILLUSTRATED HISTORY

Researcher: Assistant Professor Jack Sweetman

The objective of this project is to present a balanced, chronological history of the United States Naval Academy from its foundation to the present day. The narrative, to consist of approximately 50,000 words, will be complemented by some 200 illustrations selected by the author. Recurrent themes to be treated include: the Academy's contribution to the rise and maintenance of American sea power; the development of Academy activities and traditions; evolution of the curriculum; the balance between education and training; buildings and monuments; Academy athletics; and profiles of outstanding superintendents, famous graduates, and colorful characters. A contract for publication has been signed with the United States Naval Institute.

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## THE FEDERAL GOVERNMENT AND RESOURCE PLANNING, 1931-1935

Researcher: Associate Professor Philip W. Warken

This study analyzes the first serious efforts of the federal government to collect information on economic trends and to plan the construction of public works as anti-depression projects. It covers the years 1931 to 1935 and focuses on the activities of the Federal Employment Stabilization Board and the National Planning Board.

The FESB, established in 1931, compiled and maintained a six-year reserve of federal construction projects and coordinated construction activities with state and local governments. The NPB, established in 1933 as the planning arm of the Public Works Administration, was charged with ensuring that emergency construction projects had long term societal value.

The NPB was a more active agency and quickly saw that public works was only one aspect of a planning effort. It therefore began to expand its activities into resource planning.

In 1935, the NPB and the FESB were merged into a new independent agency, the National Resources Committee, which undertook a broad planning effort. The years 1931-1935 were formative ones in the development of a formal planning effort. This examination is designed to further an understanding of that effort.

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PUBLICATIONS

HISTORY DEPARTMENT

BRADFORD, James C., Assistant Professor, editor, A Bicentennial History of Anne Arundel County, Annapolis: Privately Printed, 1977.

The entire book is the product of the efforts of twenty-two authors with each chapter covering a particular topic or theme in the history of Anne Arundel County. Together the chapters form a comprehensive narrative of the county's past. In addition to directing the various authors and handling the composition and printing arrangements, the editor wrote a chapter entitled "Anne Arundel's Naval Heritage." This chapter narrates the county's maritime history from the first coastal defenses established during the Revolutionary War through the establishment of the Naval Academy, the Annapolis Naval Air Station (the Navy's first), to the activities of the David W. Taylor Naval Ship Research and Development Center.

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CALDERHEAD, William L., Associate Professor, "British Naval Failure at Long Island: A Lost Opportunity in the American Revolution," New York History, LVII, (July 1976), 321-338.

The British army has frequently been faulted for permitting Washington's defeated army to escape from Long Island at the end of August, 1776, thus allowing the American cause a period for recovery--that they finally returned into ultimate victory and independence. This essay examines the position of the Royal Navy in that campaign and analyzes the motives of Admiral Richard Howe in not blocking Washington's exit route. Because Howe was overconfident and excessively conservative in his operations and because Washington was a gambler, and had to be on this occasion, the Americans made their famous escape and preserved their chances for independence.

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CALDERHEAD, William L., Associate Professor, "Naval Innovation in Crisis: War in the Chesapeake, 1813," The American Neptune, XXXVI (July 1976), 206-221.

Much has been written about the war in the Chesapeake in 1814 that culminated in the British repulse at Fort Mchenry and Francis Scott Key's creation of our National Anthem. Major preparations for that remarkable summer, however, were made during the preceding year and the summer of 1813. This essay traces the events of those warm days including the probing of American defenses at Baltimore, Annapolis, and Kent Island, the first nearly successful use of the torpedo, and the emergence of Captain Charles Gordon as a minor naval hero of the War of 1812.

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CLARK, Ellery H., Jr., Associate Professor, Red Sox Forever.  
Hicksville, N.Y.: Exposition Press, 1977.

This book is a combined documentary-human interest analysis of patterns, trends, failures, and success of Boston Red Sox, 1901 through 1976. Over 70 documentary letters written during the past 54 years to the author from Red Sox players covering their 76-year spectrum to date illuminate the scholarly central theme: in order for the Bostons to have successful teams they must combine both intangible assets (team unity, dedication, pride, and determination) and tangible assets (the proven ability to play the game well in all its technical aspects). Thirty-two pages of illustrations and a complete index are included. The documentary materials test and prove the central thesis and provide the author the opportunity of making interpretations and drawing conclusions both original and of scholarly-athletic significance.

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COLETTA, Paolo E., Professor, "Bryan at Baltimore, 1912, Wilson's Warwick," Nebraska History 57 (Summer 1976), 200-225.

Given the divisions within the Democratic Party, Bryan most likely could have won a fourth presidential nomination had he desired it. Because he had run three times and lost, and for other reasons, he decided to support the candidate that best represented his own progressive principles. At first he leaned toward Champ Clark. However, when convinced that Clark was too close to Tammany Hall and not a true progressive, he won adoption of a resolution in the national convention that excluded any delegates beholden to Tammany and J. P. Morgan. His later switching of his Nebraska delegation from Clark to Wilson was probably instrumental in Wilson's victory on the 46th ballot. Bryan's brilliant parliamentary procedures and evocative oratory thus insured that a true progressive would be named at a time when a split between Taft and Roosevelt meant the election of Wilson.

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COLETTA, Paolo E., Professor, "The Perils of Invention: Bradley A. Fiske and the Torpedo Plane," American Neptune, 37 (June 1977), 111-127.

While transiting the Strait of Magellan in 1910, Fiske was amazed at the way albatross kept up with his ship and he determined to study aeronautics. While on duty with the General Board and with the fleet, he patented a torpedo plane in 1912. By the motion of a single lever he would detach a strap holding a torpedo beneath a plane and point it towards its target while at the same time igniting the starting mechanism. Unable to interest the Navy in his equipment,



he was startled following World War I to learn that the Navy was using his patented invention. He sued the Government for infringing upon his patent and after several years won his suit, meaning that the Government had to pay him \$108,000. However, a superior court found that he had never provided a working model and he lost his suit.

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LOVE, Robert W., Jr., Assistant Professor, "Bureaucracy and the Exploitation of New Technology: the Sea Powers and Naval Aviation in the Era of Disarmament," Asymmetries in Exploiting Technology, Santa Monica, Calif.: RAND Corporation (1976), pp. 1-20.

From 1921 to 1936, the sea powers sought to limit the threat of war in the Pacific by a system of arms limitations agreements. These pacts concerned the most mature weapons systems but could not contain exploitation of the new technology of military aviation. The "disarmament system" worked so long as the sea powers agreed that peace was a primary foreign policy goal. It failed when this agreement collapsed. The configuration and political alliances of the rival naval establishments were secondary influences in the growth and development of naval aviation.

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POTTER, Elmer B., Professor, Nimitz. Annapolis: U. S. Naval Institute Press, 1976.

The grandson of a German immigrant and erstwhile seafarer who built a steamboat-shaped hotel in Fredericksburg, Texas, Chester Nimitz was born in Fredericksburg four months after his father's death. Seeing no other way to finance a college education, Chester applied for an appointment to West Point, was turned down, and accepted an appointment to Annapolis. He was graduated seventh in the class of 1905 and had his first duty aboard a battleship in the Orient. In the Far East he commanded a gunboat and, while an ensign, was appointed to command a destroyer. He ran the destroyer aground and was court-martialed but was let off with a reprimand. Returning to the United States, he commanded a series of submarines. During this period he married Catherine Freeman, who accompanied him when the Navy sent him to Germany to study diesel engines. Returning to the United States, he superintended the building of a large diesel engine for an oiler. During World War I, he served as executive officer aboard the oiler and, with LCDR Henry Dinger, devised underway refueling.

After the war, Nimitz superintended the building of the submarine base at Pearl Harbor, attended the Naval War College, as tactical officer introduced the circular formation in the U.S. Fleet, and established at the University of California one of the first NROTC

units. Subsequently, as captain, he commanded the cruiser Augusta, then flagship of the Asiatic Fleet. As rear admiral, he commanded Battleship Division One and served as chief of the Bureau of Navigation. Following the Japanese attack on Pearl Harbor, President Roosevelt and Secretary of the Navy Frank Knox selected Admiral Nimitz to take command of the Pacific Fleet. He arrived at Pearl Harbor to assume this duty on Christmas day 1941.

Subsequently Nimitz was made Commander-in-Chief Pacific Ocean Areas. In this capacity, together with Admiral E. J. King, Commander-in-Chief U.S. Fleet, he devised most of the strategy that defeated Japan. He directed operations from Pearl Harbor until late 1944, when he shifted his headquarters to Guam to be nearer the westward-moving war zone. At that time he was promoted to fleet admiral. At the end of the war he signed the Japanese surrender instrument for the United States.

As Chief of Naval Operations following World War II, Nimitz had the unhappy duty of presiding over a shrinking navy. His last official act as CNO was to endorse Hyman Rickover's plan for building a nuclear-powered submarine.

His tour as CNO ended, Admiral Nimitz with Mrs. Nimitz moved to the West Coast but returned east in 1949 when the admiral was asked by the United Nations to supervise a plebiscite in Kashmir. When it became clear that the plebiscite would never take place, Nimitz resigned and returned to the West Coast, where he spent his declining years. He died in 1966 and was buried in the Golden Gate National Cemetery at San Bruno, California.

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POTTER, Elmer B., Professor, "Admiral Nimitz and the Battle of Midway," U.S. Naval Institute Proceedings, 103 (July 1976), 60-68.

The article "Admiral Nimitz and the Battle of Midway" was an adaptation of one of the chapters in the book Nimitz, intended to publicize the book.

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SWEETMAN, Jack, Assistant Professor, "Books of Interest to the Professional," United States Naval Institute Proceedings 103 (July-December 1976); 104 (February-April, June 1977).

A monthly feature of the United States Naval Institute Proceedings, this column contains capsule reviews of from 25 to 30 books of interest to the naval professional. It is divided into five topical sections: Naval Affairs; Maritime Affairs; Military Affairs; International Affairs; and General.

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SWEETMAN, Jack, Assistant Professor, "Aboard Subchaser 206." United States Naval Institute Proceedings, 103 (September 1976), 69-71.

The experiences of a young seaman serving aboard an American sub-chaser in European waters in World War I are recounted in an article based on the posthumous papers of Mr. Blanchard M. Neal. Neal enlisted in the navy and was assigned to Subchaser 206 in April 1918. His boat crossed the Atlantic in June 1918 and spent the next five months on anti-submarine patrol in the Irish Sea. Following the Armistice, it was attached to the North Sea Minesweeping Detachment and participated in clearing the great Allied mine barrage between the Orkneys and the coast of Norway.

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SWEETMAN, Jack, Assistant Professor, "Notable Naval Books of 1976." United States Naval Institute Proceedings, 104 (January 1977), 95-99.

This article reviews the author's selection of the most outstanding books on naval and maritime affairs published in 1976. A total of eighteen titles are treated:

Battleships: United States Battleships in World War II by Robert O. Dulin, Jr. and William H. Garzke, Jr.

Combat Fleets of the World 1976/77: Their Ships, Aircraft and Armament by Jean Labayle Couhat, editor.

Dictionary of American Naval Fighting Ships: Volume VI, R-S, Washington, D. C.: Naval History Division.

Electronics and Sea Power by Vice Admiral Sir Arthur Kezler, KBE, CB, DSO, DSC, Royal Navy (Retired).

How the Battleship MAINE was Destroyed by Admiral Hyman G. Rickover, U. S. Navy.

Jane's Fighting Ships: 1976-77 by Captain John E. Moore, Royal Navy (Retired), editor.

Letters and Papers of Alfred Thayer Mahan by Robert Seager II and Doris Maguire, editors.

Marines in the Revolution: A History of the Continental Marines in the American Revolution, 1775-1783 by Charles R. Smith.

Mr. Roosevelt's Navy: The Private War of the U. S. Atlantic Fleet, 1939-1942 by Patrick Abbazia.

Naval Policy between the Wars Volume II: The Period of Reluctant Rearmament 1930-1939 by Captain Stephen Roskill, Royal Navy (Retired).

PUBLICATIONS

HISTORY DEPARTMENT

Night Action: MTB Flotilla at War by Captain Peter Dickens, DSO, MBE, DSC, Royal Navy (Retired).

Nimitz by E. B. Potter.

On Watch: A Memoir by Admiral Elmo R. Zumwalt, Jr., USN (Retired).

Ships and Aircraft of the U. S. Fleet by Samuel L. Morison and John S. Rowe.

The Soviet Naval Offensive by Rear Admiral Edward Wegener, Federal German Navy (Retired).

The Soviet Navy Today by Captain John E. Moore, Royal Navy (Retired).

Titans of the Seas: The Development and Operations of Japanese and American Carrier Task Forces during World War II by James H. Belote and William M. Belote.

The United States Marines, 1775-1975 by Brigadier General Edwin H. Simmons, USMC (Retired).

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SYMONDS, Craig L., Assistant Professor, Charleston Blockade: The Journals of John B. Marchand, USN, 1861-1862. Newport: Naval War College Press, 1976.

This volume is composed of material derived from the private journals, letters, and official reports of Commander, later Captain John B. Marchand, USN, who served as the senior officer on the Charleston blockade during the Civil War. The previously unpublished papers are tied together with connective material written by the editor which makes up about 35% of the volume and makes the whole a meaningful narrative.

The narrative begins when Marchand is assigned to command the U.S.S. James Adger, and ends when he is ordered from the James Adger to command a new ship. While on the Adger, Marchand steams to Europe in pursuit of Mason and Slidell, becomes involved in foreign intrigue in London, takes part in the expedition against Fernandina, Florida, explores the Stono River as a possible avenue for an attack on Charleston, and, of course, chases, and boards, would-be blockade runners. Throughout the narrative, however, run the themes of boredom, monotony, ambition, anxiety, and doubt. It is as much a personal memoir of a sailor as an account of the blockade.

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PUBLICATIONS

HISTORY DEPARTMENT

WARKEN, Philip W., Associate Professor, "Intervention in Laos, 1954-1974," in Dictionary of American History, New York: Charles Scribner's Sons, 1976.

In 1954, the Geneva accords established an independent Laos and provided that its government should encompass all political factions, including the Communist Pathet Lao. American policymakers, however, opposed a coalition government and a neutralist foreign policy. In an effort to change the direction of Laotian policy, the United States periodically suspended aid to the government but, as this seemed counterproductive, increasingly turned to covert intervention in Laotian political affairs. U. S. action was motivated by a commitment to the containment of communism and a belief that if one country fell to the Communists, another and then another would also fall, the so-called domino theory. U. S. activities in Laos were terminated at the time of the withdrawal of American troops from Vietnam in 1975--Laos had a coalition government and favored a neutralist foreign policy.

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PRESENTATIONS

HISTORY DEPARTMENT

CALDERHEAD, William L., Associate Professor, "The Navy in the Chesapeake, War of 1812." Paper read at the Military History Roundtable, Baltimore, 18 November 1976.

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CALDERHEAD, William L., Associate Professor, "Two Hundred Years of Black History in Anne Arundel County." Paper read at Bicentennial Symposium, Annapolis, 23 November 1976.

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COLETTA, Paolo E., Professor, "The United States and Italy in the Allied Naval War Council of World War I." Paper read at Genova, Italy, 22-30 May 1976.

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ESTES, Kenneth W., Captain, USMC, "Student and Computer Dialogue." Paper read at WABA Symposium on Computers in Education, U.S. Naval Academy, Annapolis, 18 May 1977.

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HAGAN, Kenneth J., Assistant Professor, "19th Century Origins of Contemporary American Naval Strategy." Paper read at the Marine Corps Staff College, Quantico, Virginia, October 1976, and at the U.S. Foreign Service Institute, Washington, D. C., December 1976.

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HARROD, Frederick S., Assistant Professor, "Enlisted Personnel in American Military History." Paper read at George Washington University, Washington, D. C., 24 May 1977.

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JOHNSON, David E., Associate Professor, "Russell on General Facts." Paper read at the Eastern Division of the American Philosophical Association meeting, Boston, 27 December 1976.

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LOVE, Robert W., Jr., Assistant Professor, "Bureaucracy and the Exploitation of Technology: Naval Aviation in the Era of Disarmament." Paper read at Rand Corporation Seminar, Washington, D.C., 8 May 1976.

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PRESENTATIONS

HISTORY DEPARTMENT

LOVE, Robert W., Jr., Assistant Professor, "Anglo-American Naval Diplomacy and the Second Front, 1942." Paper read to the annual meeting of the Association of Contemporary Historians, Institute of Historical Research, University of London at London, 10 July 1976.

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LOVE, Robert W., Jr., Assistant Professor, "British Foreign Policy and the American Civil War: The Lyons-Seward Treaty of 1862." Paper read to the annual meeting of the Conference on British Studies, Snowbird, Utah, 8 October 1976.

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LOVE, Robert W., Jr., Assistant Professor, "The Irrelevance of Command of the Sea." Paper read at the Marine Corps Staff College, Quantico, Virginia, October 1976.

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POTTER, Elmer B., Professor, "The Navy and the Merchant Marine: A Fruitful Partnership." Paper read at Sea Power Seminars sponsored by the Navy League of the United States, at New Orleans, 25 August 1976, and at Chicago, 20 March 1977.

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POTTER, Elmer B., Professor, "Sea Power: Pittsburgh's Lifeline." Paper read at the Bicentennial Seapower Symposium sponsored by the Navy League of the United States, Pittsburgh, 9 November 1976.

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THOMAS, James P., Jr., Associate Professor, "Heraldry." Paper read to the Annapolis chapter of MENSA, February 1977.

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DIVISION OF  
MATHEMATICS AND SCIENCE

## CHEMISTRY DEPARTMENT

Commander John M. Hoffmann, USN, Chairman

The research efforts of the Department continue to mirror the diversity that is chemistry and the pronounced extension contributed by two active biologists.

Starting with the more theoretical end of the spectrum we have a truly prolific worker (Montgomery), who has published three papers on the bonding states of diatomic molecules as well as directing a student in the development of a computer program to analyse nuclear magnetic resonance spectra. Still in the fundamental vein, we have worked on the kinetics of the decarboxylation of malonic acids (Jones), the study of the distribution of carboxylic acids between solvent phases (Koubek) and the preparation of 1,2,3-triphenylcyclopropane (Hoffmann).

A fair proportion of the research relates to environmental and other applied problems of the Navy. The David Taylor Naval Ship Research and Development Center supported work on antifouling paints (Ressler), detergent efficiency (Zimmerman), quantitative determination of detergents in waste water (Massie) and prevention of corrosion of copper-nickel pipe by polluted water (Gomba). Several sources supported work on explosives including the determination of RDX in effluents (Prestia), the photochemical decomposition of such nitramines (Rowell) and the preparation of a standard liquid propellant (Rowell).

Of a more biological flavor is the research on the copper-catalysed oxidation of hemoglobin (Lauer), genetics research (Weingartner), preparation of anticancer agents (Trident Scholar Gerhard) and the extensive field program on the water quality of the Severn River (Corey).

With roughly 45% of the Department doing research and with many of them involving students in their research, the contribution of these scholarly efforts to the educational mission of the Academy is significant. The publication of some of these results in the open literature and the service to the Navy offered by many others enhances the prestige of the Naval Academy in both the civilian and naval communities.

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OXIDATION OF  $S^{2-}$  by  $Cl_2$ 

Researcher: Associate Professor Frank J. Gomba

Sponsor: David W. Taylor Research and Development Center, Annapolis Laboratory

Unexpected corrosion of 90-10 Cu-Ni pipes aboard surface vessels being outfitted on the James River has led to the proposal that  $S^{2-}$  was responsible due to the pollution of the river by sewage. Chlorinators have been successful in treating seawater to prevent fouling of Ti alloy tubing and in preparing potable water from seawater aboard ship. This investigation was concerned with the rate of oxidation of  $S^{2-}$  by  $Cl_2$  to see if chlorinators can also effectively remove  $S^{2-}$  from seawater and thus prevent corrosion of the condenser tubes. This investigation has shown that the rate of oxidation of  $S^{2-}$  by  $Cl_2$  is quite fast, providing there is efficient mixing of the seawater with  $Cl_2$ . Conventional methods of following the rate have proven unsuccessful. Competition reactions of  $Cl_2$  with phenol (rate known) versus  $Cl_2 + S^{2-}$  have shown that the first order rate constant is at least of the order of  $10^5 \text{ sec}^{-1}$  and not greater than  $10^{11} \text{ sec}^{-1}$  (rate of proton transfer), at  $25^\circ\text{C}$ . Since the half-life of  $S^{2-}$  in oxidation studies by oxygen is of the order of 17 minutes, the  $Cl_2$  oxidation of  $S^{2-}$  should be nearly of the same order. It appears that assumption of the role of  $S^{2-}$  in corrosion of the condenser tubes may be unwarranted unless inefficient mixing of seawater with air occurs. While chlorinators may be effective initially in removing  $S^{2-}$ , the generation of  $ClO^-$  may also serve as a corrosive agent.

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## THE pH DEPENDENCE OF THE OXIDATION OF HUMAN HEMOGLOBIN BY COPPER (II)

Researcher: Ensign Linda D. Lauer, USNR

Sponsor: Naval Academy Research Council

The reversible oxygenation of hemoglobin involves the binding of oxygen to the ferroporphyrin (protoheme) group. Therefore, the effective transport of oxygen requires that the oxidation of hemoglobin be minimized, and it becomes important to understand the various mechanisms by which hemoglobin can be oxidized.

Previous studies of the oxidation of human hemoglobin by  $Cu(II)$  have shown major disagreements in the mechanism of the reaction and in the catalytic effect (if any) of copper ions in the oxidation. These studies, however, were not carried out at the same pH. The objective of this project is to examine the oxidation reaction at various pH values and copper concentrations.



Research previously conducted at pH 7.4 has led to the conclusion that Cu(II) can be bound to the protein portion of the hemoglobin molecule. The binding has been proposed to take place to the  $\beta$ -2 histidine residue; copper bound in this manner cannot oxidize hemoglobin.

Preliminary experiments indicate that the oxidation of oxyhemoglobin is pH-dependent, and that the rate of oxidation increases as the pH decreases. In view of the pKa of histidine (5.6-7.0 in proteins), it is reasonable to suppose that as the pH of a hemoglobin solution is decreased from pH 7.4, more of the  $\beta$ -2 histidine residues are protonated. This precludes binding of copper(II), and therefore increases the effective free copper ion concentration in the oxidation reaction.

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#### A STUDY OF ANALYTICAL METHODS FOR QUANTIFYING DETERGENTS IN WASTE WATERS

Researcher: Professor Samuel P. Massie

Sponsor: David W. Taylor Research and Development Center, Annapolis Laboratory

Measurement of the absorbance at 320 m $\mu$  of the blue complex formed from non-ionic detergents, conforming to Mil-D-16791 specifications, and ammonium cobalthiocyanate with subsequent extraction by benzene from saturated sodium chloride solution has been shown to be a satisfactory method of determining quantitatively the concentrations of these detergents in concentrations between 25-200 ppM with best results being between 50-75 ppM.

The technique has been shown to be satisfactory in distilled water, synthetic seawater, and filtered Severn River water.

The presence of oils at concentrations of 75 ppM did not affect the absorbance at 320 m $\mu$ .

While complexes from each detergent showed absorbance at 320 m $\mu$ , each detergent needed its own calibration. The method needs further study and refinement.

Concurrent studies by a technician were comparable and showed that the method was of general utility.

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## APPLICATIONS OF VARIATIONAL PERTUBATION THEORY TO DIATOMIC MOLECULES

Researcher: Lieutenant Henry E. Montgomery, Jr., USN

Sponsor: Naval Academy Research Council

Accurate wavefunctions for the  $2\Sigma^+(1s\sigma_g)$  and  $2\Sigma_u^+(2p\sigma_u)$  states of the hydrogen molecular ion have been obtained by diagonalization of the von Koch determinants which result when the Schrodinger equation is expressed in elliptic coordinates. The wavefunctions have been used to calculate expectation values for the total energy, the kinetic energy, the potential energy and the quadrupole moment integrals  $\langle X^2 \rangle$  and  $\langle Z^2 \rangle$ . A method for determining which regions of the wavefunction contribute most to a given expectation value has been developed and used to generate contribution profiles for each operator. The expectation values and their profiles are being used to evaluate the accuracy of approximate wavefunctions.

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## POLAROGRAPHY OF RDX HYDROLYSIS PRODUCTS IN EFFLUENT OF ION EXCHANGE COLUMN TREATMENT OF RDX WATER

Researcher: Assistant Professor John V. Prestia

Sponsor: Naval Sea Systems Command

The hydrolysis of RDX in basic solution has been studied and the products of the decomposition have been identified. Dr. John Hoffsommer at the Naval Surface Weapons Center has noted that this same kind of decomposition of RDX takes place on an ion exchange column (Amberlite 410-strongly basic form) and is currently involved in scaling up this process in order to treat waste streams from loading and/or demilitarization operations.

It is highly desirable to have a simple monitoring device on the effluent side of this column in order to know when the column has failed or when the column needs to be regenerated. This project involves the use of rapid scan single sweep polarography at a hanging mercury drop electrode as a possible monitoring device.

RDX is known to show reduction waves in the range -0.4 to -1.3 (versus SCE) and a Field Polarograph has been developed by Becktel and Whitnack at the Naval Weapons Center, China Lake, which might be adaptable to this application. By analyzing both the RDX water input and the effluent from the ion exchange columns, results of this research show that RDX at levels of about 0.5 ppm in the effluent streams may be detected by polarograph methods. Attempts to identify products of the decomposition by polarography have been unsuccessful to date. Reductions of other nitro-containing compounds such as nitrobenzene,

nitromethane, and more importantly dimethylnitramine (since RDX is a nitramine), indicate that it is the reduction of the nitro groups of the RDX that is responsible for the observed reduction waves.

Details of this study have shown that the limit of detectability (about 0.5 ppm RDX) and the fact that the known decomposition products do not appear to interfere make the polarographic method a viable candidate for monitoring the effluent streams of the decomposition processes. Further work in this area would have to be centered on the hardware to be used, portability, etc. The Field Polarograph mentioned can probably be utilized.

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## ANTIFOULING COATING

Researcher: Associate Professor Robert R. Ressler

Sponsor: David W. Taylor Research and Development Center, Annapolis Laboratory

The major effort expended was an exhaustive search of the literature, searching for what has been done, to date, in the way of developing epoxy coatings for marine vessels subject to corrosion, fouling, and the mechanical destruction resulting from abrasion and cavitation at high speeds. In particular epoxy systems are amenable to the relatively uncomplicated application procedures suitable for drydocking operations. Epoxy coatings are potentially most interesting because of their generally good properties and because the procedures are available for incorporating antifouling properties.

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## PREPARATION OF A MODEL LIQUID PROPELLANT

Researcher: Associate Professor Charles F. Rowell

Sponsor: Naval Ordnance Station, Indian Head

The purpose of the research was to prepare a "standard sample" of highly purified NOS 365 to permit measurement of reference properties for both design and quality control.

A method of preparation of the components by a technique which avoided the possibility of producing the most common impurities found in manufacturing was developed and used to prepare one-half kilogram of the desired material. The product was carefully analysed for trace metals in order to set limits as to maximum contamination possible in the reference. The prepared sample proved to have physical properties quite different from the manufacturer's material in that it crystallized to some extent on standing..

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## FATE OF PHOTOPRODUCTS OF NITRAMINES

Researcher: Associate Professor Charles F. Rowell

Sponsor: Naval Academy Research Council

In a series of studies on the photochemistry of nitramines, it has been shown that nitroxides are produced. From literature sources, it is known that such molecules lead to hydroxylamines in many cases. The immediate object of this study is to prepare a model compound, N-hydroxypyrrolidine, and study its reactions with other photoproducts such as NO.

To date, the model compound has been prepared and a mode of isolation worked out. The preparation of a larger quantity and initiation of reaction studies will follow during the summer of 1977.

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## DETERGENT CLEANING EFFICIENCY, EMULSION FORMING, AND STABILITY

Researcher: Professor John G. Zimmerman

Sponsor: David W. Taylor Research and Development Center, Annapolis Laboratory

Bilge waters containing oil and grease are frequently difficult to separate into two distinct phases because of solubilization and emulsification promoted by surfactants or detergents present in the water. The result is that waste-waters to be discharged overboard may not meet the EPA limit for oil content. Control of the nature of the detergents used aboard ship may be the least expensive approach to the solution of the problem and may produce the quickest results.

A method of measuring the relative cleaning efficiency of detergents was developed and used to rate twelve different detergent preparations: four conforming to the specification MIL-D-16791E (Nonionic General Purpose Detergent), 1 conforming to the specification MIL-C-22230A (Fuel Tank and Bilge Cleaning Compound), and 7 commercial preparations not conforming to either specification. The seven most efficient detergents were selected for emulsion stability studies. For this purpose a method of producing emulsions of oil in water containing detergent was developed and the stability of the emulsions determined by measurement of the concentration of oil immediately after formation of the emulsion and 2, 24, and 48 hours later. The oil analysis employed an IR method developed in prior studies at the Annapolis Laboratory. To provide further insight into the separation problem the emulsion samples were also subjected to a drop-count analysis using a Coulter Model TA-II counter.

In the cleaning efficiency test, only 7 of the 12 detergents were capable of removing more than 10% of the soil layer from a metal strip when stirred in accordance with the test conditions in tap water or seawater containing up to 30 ml of the detergent per liter. The seven selected detergents included all of the MIL-D and MIL-C preparations plus two commercial products.

One commercial preparation, a nonionic polyoxyalkylene glycol, rated second in cleaning efficiency but in the emulsion stability studies was superior to all the others, leaving only 3 to 10 mg oil per liter after 48 hours in either tap water or seawater. Even at 24 hours the oil concentration was 10 mg per liter or less when this detergent was used to prepare the emulsion despite the fact that the emulsion originally contained 360 to 370 mg oil per liter.

In view of the results obtained it was recommended that this commercial preparation be used on a trial basis aboard a number of Navy ships and that the MIL-D-16791E specification be modified to include formations of the polyoxyalkylene glycol type.

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#### THE SYNTHESIS OF NITROGEN MUSTARD DERIVATIVES OF HYDANTOINS AND RELATED COMPOUNDS AS POTENTIAL ANTI-BRAIN TUMOR AGENTS

Researcher: Midshipman 1/C H. John Gerhard

Advisor: Professor Samuel P. Massie

Sponsor: Trident Scholar Program

The primary methods of cancer treatment have, for decades, been surgery and radiotherapy. These local modalities are limited with respect to the eradication of occult metastases. Consequently, investigators have turned to systemic treatments, such as chemotherapy and immunotherapy, which are, at least theoretically, capable of eliminating disseminated disease.

Medical investigation into possible central nervous system (CNS) chemotherapeutic agents has generated interest in the nitrogen mustard derivatives of hydantoins for several reasons:

- 1) Hydantoins have exhibited ability to penetrate the blood-brain barrier in adequate concentrations to produce the desired chemotherapeutic effect without the control complications which would arise with base molecules such as barbiturates.



SPONSORED RESEARCH

CHEMISTRY DEPARTMENT

2) Nitrogen mustard has produced demonstrated antitumor activity; hence, it is assumed that increased cellular influx of the antitumor function would accompany the attachment of a nitrogen mustard alkylating group to transport nuclei, such as the hydantoins.

Further, the particular structures, varied through variation of alkyl groups  $R_1$  and  $R_2$ , selected for study are chosen for the value of their log partition coefficient, a measure of membrane transport, approximately 2.0, a value that is common among CNS chemicals.

The preparation of these compounds involved four steps: preparation of the hydantoins, their conversion into mononitrogen mustard derivatives, subsequent modification into dialcohols, and, finally, conversion into di-nitrogen mustard derivatives. While the preparation of the hydantoins was successful, problems were encountered in subsequent preparative steps.

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INDEPENDENT RESEARCH

CHEMISTRY DEPARTMENT

WATER QUALITY OF THE SEVERN RIVER

Researcher: Professor R. Reece Corey

Water quality was monitored at 15 stations in the Severn River.

Determinations were made of total and fecal coliforms, dissolved oxygen, temperature, and turbidity. The object was to obtain baseline data of water quality in the Severn River. The data indicates two main sources of pollution, namely, surface runoff and Severn Run.

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RESEARCH COURSE PROJECTS

CHEMISTRY DEPARTMENT

ISOLATION AND IDENTIFICATION OF SALMONELLA SP. FROM SEA GULL FECES

Researcher: Midshipman 1/C William S. Adsit

Adviser: Professor R. Reece Corey

Sea gull feces were inoculated onto Salmonella-shigilla agar, a medium designed for isolation of these organisms. Isolates from this medium were subcultured and identified using twenty biochemical tests.

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ISOLATION AND IDENTIFICATION OF FECAL COLIFORMS FROM SEA GULL FECES

Researcher: Midshipman 1/C Raymond E. Bozman

Adviser: Professor R. Reece Corey

Sea gull feces were weighed and diluted. The diluted suspension was filtered through a membrane filter and cultured on fecal coliform selective media at 44.5°C according to the procedure of "Standard Methods," American Public Health Association. Representative colonies were subcultured and identified by twenty biochemical tests.

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KINETICS OF DECARBOXYLATION OF SUBSTITUTED MALONIC ACIDS IN AQUEOUS AND MIXED SOLVENT SOLUTIONS

Researcher: Midshipman 1/C Daniel J. Butler

Adviser: Associate Professor O. Lloyd Jones

This work is a continuation of a comprehensive research project which has been underway at the Naval Academy for several years. It involves the preparation of substituted malonic acids and the kinetic study of their decarboxylation under varying solution conditions (temperature, solvent, pH, concentration, and ionic strength) with the intent of elucidating the mechanism of decarboxylation. These reactions are unusual in that the dianions appear stable towards decarboxylation, whereas the monoanions and undissociated acids react spontaneously and at different rates. Steric and inductive effects may both influence the rates of reaction. Since the number of variables involved is large, appreciable data must be collected before valid conclusions can be drawn. This portion of the overall project involves the preparation and study of one substituted acid in aqueous solutions of varying pH and temperature, with ionic strength and concentration being held constant. The data obtained lends itself well to computerization, which was done successfully.

RESEARCH COURSE PROJECTS

CHEMISTRY DEPARTMENT

-- An offshoot of this project involved the development of methods for the determination of dissociation constants of polyprotic acids in those cases where successive constants are within an order of magnitude, making standard techniques of determination invalid.

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CORRELATION OF FECAL-COLIFORM COUNTS WITH WATER TEMPERATURE IN THE SPRING

Researcher: Midshipman 1/C Randall C. Franke

Adviser: Professor R. Reece Corey

Water quality of Weems Creek at two stations and the Severn River at two stations was monitored for coliform bacteria. Counts were made for fecal coliforms using the membrane filter method of "Standard Methods," American Public Health Associate. The object was to determine if any relationship existed between temperature and coliform counts.

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EXAMINATION OF SEA GULL FECES FOR HEAVY METALS

Researcher: Midshipman 1/C Thomas J. Frey

Adviser: Professor R. Reece Corey

Sea gulls, being scavengers, frequently feed on garbage, waste, and the bodies of other dead creatures. If these died as the result of toxic effects, the material may in turn be accumulated in the sea gull. As a preliminary investigation, sea gull feces were examined for heavy metals by mass spectrometer.

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PREPARATION OF N-HYDROXYPYRROLIDINE

Researcher: Midshipman 2/C Thomas Hovatter

Adviser: Associate Professor Charles F. Rowell

N-hydroxypyrrolidine is a model compound for a suspected intermediate in the photochemical decomposition of the military explosives that contain nitramine functional groups. (HMX, RDX, tetryl). A two-step synthesis of the title compound has been perfected and the best conditions for yield determined.

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## MERISTEMING AND THE INDUCTION OF POLYPLOIDY

Researcher: Midshipman 1/C Thomas K. Huisman

Adviser: Assistant Professor David L. Weingartner

Orchid plant are cloned by culturing meristem tissue in sterile nutrient solution. Colchicine will be used to induce development of a polyploid condition in some of the clones, and chromosome counts will be performed to study the results.

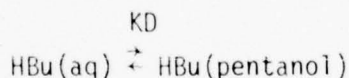
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## A SOLVENT EXTRACTION EXPERIMENT FOR THE FRESHMAN LABORATORY

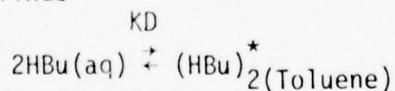
Researcher: Midshipman 3/C Peter Johnstone

Adviser: Professor Edward Koubek

An experiment has been developed to introduce beginning students to the principles of solvent extraction. This experiment involves the extraction of butyric acid from aqueous solution into either pentanol or toluene. These particular solvents have been chosen in order that the student will also be introduced to the concept of hydrogen bonding. This stems from the fact that the distribution of butyric acid between water and pentanol may be represented by the expression



while with toluene one finds



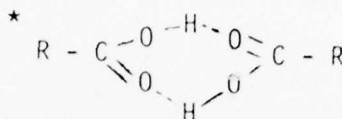
thus the appropriate distribution functions became

$$K_D^I = \frac{[\text{HBu}]_p}{[\text{HBu}]_w} \text{ for pentanol}$$

and

$$K_D^I = \frac{[\text{HBu}]_T}{[\text{HBu}]_w} \text{ for toluene}$$

This experiment, as developed for the freshman laboratory has been accepted for publication in The Journal of College Science Teaching.



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#### INDUCING MUTATIONS WITH RADIATION

Researcher: Midshipman 1/C Kilton Kingsman

Adviser: Assistant Professor David L. Weingartner

Research was undertaken concerning the mutation effects of radiation on embryonic plant tissues. Ultraviolet rays and X-rays were employed, and their effects on the chromosomes and the expressed phenotypes were studied.

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#### ISOLATION AND IDENTIFICATION OF SPORE-FORMING ANAEROBIC BACTERIA FROM SEA GULL FECES

Researcher: Midshipman 1/C William J. Lester

Adviser: Professor R. Reece Corey

Sea gull feces were cultivated anaerobically in a meat medium stained for spores, and purified by streaking on blood agar. Typical colonies were subcultured and identified with biochemical tests.

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#### DETERMINATION OF COAT COLOR IN MICE

Researcher: Midshipman 1/C Jerry M. Linenger

Adviser: Assistant Professor David L. Weingartner

Mouse breeding experiments are being carried out to determine the nature of the genes responsible for producing the four observed phenotypic color patterns.

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## ISOLATION OF ANTIBIOTIC-RESISTANT MUTANTS OF BLUE-GREEN ALGAE

Researcher: Midshipman 1/C Harry F. Meyers

Adviser: Professor R. Reece Corey

In order to study genetics of any organism, a number of mutants must be obtained as a first step. Antibiotic-resistant mutants are among the most common spontaneous mutants in bacteria. The same techniques, namely, pure culture and gradient plate techniques, were adapted to blue-green algae to determine if naturally occurring mutants to any of five antibiotics could be isolated.

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## SMALL-RING COMPOUND SYNTHESIS

Researcher: Midshipman 2/C Scott Stafford

Adviser: Commander John M. Hoffmann

Laboratory synthesis of various substituted cyclopropanes was undertaken in an attempt to prepare 1,2,3-triphenylcyclopropane. The principal route to the variously substituted cyclopropanes is via the formation of substituted 1-pyrazolines followed by base catalyzed thermal decomposition to form the cyclopropanes. Yield for these preparations are reduced as more bulky substitutions are added to the basic 5-membered pyrazoline rings. The 1,2,3-triphenylcyclopropane has been prepared and characterization is underway using infra red and nuclear magnetic resonance spectroscopy. The ultimate goal of the synthetic work is to prepare the dimer of the 1,2,3-triphenylcyclopropane with the two rings joined in three places through para-substituted methylene groups.

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## DEVELOPMENT OF AN NMR SPECTRAL ANALYSIS PROGRAM

Researcher: Midshipman 1/C Chris C. Willson

Adviser: Lieutenant Henry E. Montgomery, Jr., USN

A nuclear magnetic resonance spectral analysis program has been developed for use on the USNA/DTSS time-sharing system. The program can be used either to generate theoretical spectra or to perform iterative least-squares analysis of observed high-resolution spectra. The program is being used in an investigation of the solvent dependence of proton-proton coupling constants in a set of simple organic solutes.

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PUBLICATIONS

CHEMISTRY DEPARTMENT

LAUER, Linda D., Ensign, USNR, co-author, "Copper and the Oxidation of Hemoglobin: A Comparison of Horse and Human Hemoglobins," Biochemistry, 15 (1976), 5337-5343.

Oxidation studies of hemoglobin by copper(II) indicate that for horse hemoglobin, up to a Cu(II)/heme molar ratio of 0.5, all of the Cu(II) added is used to rapidly oxidize the heme. On the other hand, most of the Cu(II) added to human hemoglobin at low Cu(II)/heme molar ratios is unable to oxidize the heme.

Binding studies by equilibrium dialysis indicate that horse hemoglobin has one Cu(II) binding site per heme. Human hemoglobin, however, has an additional binding site, involving one copper for every two hemes, which has a higher copper affinity than the single horse hemoglobin binding site. The Cu(II) oxidation of human hemoglobin is explained by a mechanism where electron transfer cannot occur between the heme and the Cu(II) bound to the high affinity binding site. The electron transfer must involve the Cu(II) bound to the lower affinity site, which is similar to the single binding site in horse hemoglobin. The involvement of  $\beta$ -2 histidine in the additional site is indicated by a comparison of the oxidative behaviors of various hemoglobins which possess this site (human and rabbit) and those that do not (horse, sheep, and bovine).

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PRESENTATIONS

CHEMISTRY DEPARTMENT

MONTGOMERY, Henry E., Jr., Lieutenant, USN, "One-Electron Wavefunctions. Accurate Expectation Values for the Hydrogen Molecular Ion." Paper read at the 11th American Chemical Society Middle Atlantic Regional Meeting, Newark, Delaware, 21 April 1977.

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## COMPUTER SCIENCE DEPARTMENT

Commander Kenneth G. Clark, USN, Chairman

The Computer Science Department has engaged in a modest research effort since its inception in 1971. An important part of the Department's research effort during the year has been the involvement of midshipmen in independent research dealing mainly with software design. Evaluation of a Basic Instructional Program designed by Stanford University for the U. S. Navy was completed during this research year. Sponsored research dealt with the gap between existing computer software designed to assist in preparing Environmental Impact Assessment Statements and potential users' lack of awareness of the existence or utility of these systems.

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## BASIC INSTRUCTIONAL PROGRAM (BIP) EVALUATION

Researcher: Commander Kenneth G. Clark, USN

Sponsor: Navy Personnel Development Research Center - San Diego

Commander Kenneth G. Clark, USN, conducted an evaluation of BIP (Basic Instructional Program), a computer-aided-instruction for learning programming in the BASIC programming language. The system was designed by Stanford University for the U. S. Navy. The evaluation included a 3-day visit to Stanford to learn the system. The principal investigator then implemented the system at the Naval Academy, organized the test group, established measurement and grading techniques, taught the test group how to use the system, and prepared the final evaluation report.

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## BRIDGING THE GAP BETWEEN ENVIRONMENTAL DATA SYSTEMS AND POTENTIAL USERS

Researcher: Assistant Professor Frederick A. Skove

Sponsor: Naval Facilities Engineering Command (Code 032D)

The Construction Engineering Laboratory (CERL) in Champaign-Urbana has developed a series of computerized programs designed to assist personnel involved in writing Environmental Impact Assessments and Environmental Impact Statements. These programs have been developed at considerable cost to the government. It would seem that a considerable savings would result from full utilization of these programs. At present the Navy has no systematic approach to the writing of EIAs and EISes. CERL has developed three specific programs which were examined in this study. The Environmental Impact Forecast System (EIFS) is designed to assess the economic and social impact of construction, mission change, training, and operations and maintenance programs. The Environmental Impact Computer System (EICS) provides a basis for identifying environmental impacts and suggests means by which harmful impacts may be mitigated. The Computer-Aided Environmental Legislative Data System (CELDS) is designed to provide easy access to the abstracts of key or relevant federal and state laws as regards environmental protection.

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## TRANSPORTABLE COMPILER IMPLEMENTATION VIA ITERATIVE ENHANCEMENT

Researcher: Assistant Professor John L. Jones

Sponsor: Naval Academy Research Council

This research proposal involves the use of iterative enhancement to implement an already existing compiler. The compiler is a transportable one and has been transported to two other computer systems using different methods of transportation, direct object code generation and intermediate translation using another common language, SNOBOL. The results of this research effort will give another measure of the time necessary for a given large scale software project implementation.

The SIMPLE-T compiler is currently implemented on the UNIVAC 1108 under the EXEC 8 operating system. The compiler itself is written in SIMPLE-T and consists of approximately 6000 lines of code. It is logically divided into a macro generator, a scanner, a parser and a code generator. In order to transport SIMPLE-T to the H-635 or any other computer system, it is necessary to change the code generation phase to produce code for the new target machine. The choice of how much to implement on any one enhancement is the first objective of this research. This will produce the set of project tasks. The actual implementation and enhancement will be the major goal of this research.

An effective measure of reliability and changeability would be the effort required to perform any particular iteration. The measure of effort, in man-hours expended or in number of modules changed or in number of actual lines changed can then be taken to indicate the difficulty of the actual enhancement process. In particular, if the design is good, later enhancements should not be more difficult than earlier ones.

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## STRUCTURED IMPLEMENTATION OF AN INTERACTIVE SIMULATOR

Researcher: Midshipman 1/C Thomas P. Breyer

Adviser: Assistant Professor John L. Jones

Most large discrete simulation systems such as GPSS, simula and simscript were designed to operate in a strictly batch environment. In most simulations there exists a need to investigate the status of many systems parameters such as the size of various queues and average waiting times to see if a steady-state condition has been reached. An interactive simulation system, in which the user can dynamically alter these items during the flow of the simulation, would greatly aid the program developer by cutting down on the development time.

The design approach is to start with a core kernel of the simulator and gradually add modules as the previous version is verified. Combining this approach with a documented top-down design has been shown in several cases to allow a much faster implementation schedule. The other major advantage of this design approach is to allow users of the system to be involved with the design by using the system at its various stages of development.

The work in this project involves the coding and check-out of the kernel of the simulator. The actual simulator syntax is based on GPSS, and the implementation language to be used is the DXPL version of XPL available on the Dartmouth Time Sharing System.

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## SIMULATION OF THE DARTMOUTH TIME SHARING SYSTEM

Researcher: Midshipman 1/C Thomas P. Breyer

Adviser: Assistant Professor John L. Jones

In order to study more easily the effect of hardware or software changes to any existing computer system, it is useful to have a simulation of that system available. This project involves the creation of a simulation of the Dartmouth Time Sharing System as configured at the U. S. Naval Academy, written in GPSS and running on the batch version GESIM available on the Honeywell 635 operating under GECOS.

Daily system statistics on memory, CPU, and I/O usage are studied and synthesized to produce the necessary distribution functions in modelling the DTSS. A first cut at the simulation has been built and tested which includes the memory scheduling algorithm but does not include detailed operation of the I/O subsystem. The next stage of development would include the I/O.

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MICROMAP CROSS ASSEMBLER FOR THE INTEL 8080 MICROCOMPUTER

Researcher: Midshipman 2/C Benjamin Richter

Adviser: Lieutenant Commander Jay A. Sears, USN

The purpose of the project was to construct a high-speed assembler language translator for the Intel 8080 Microprocessor. Upward compatibility was essential for the software since advanced microprocessors with expanded instruction sets are likely to be introduced in the near future. The Micromap Assembler was written in the language DXPL and runs on the DTSS system. It produces absolute object code for loading by a microcomputers system monitor. A MICROMAP Users Manual was developed to provide detailed information on the Assembler and its special capabilities. Object code has been produced and transferred to a Tektronix 4051 tape cartridge and then successfully loaded in the MCS-80 microcomputer maintained by the Computer Aided Design/Interactive Graphics Group in Rickover Hall.

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PRESENTATIONS

COMPUTER SCIENCE DEPARTMENT

JONES, John L., Assistant Professor and William R. WILSON, Lieutenant Commander, USN, "Large Course Administration." Paper read at the Washington-Annapolis-Baltimore-Area Symposium on Computers in Education, U. S. Naval Academy, 18 May 1977.

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## MATHEMATICS DEPARTMENT

Professor Theodore J. Benac, Chairman

Research has become an integral part of the professional activities of the Mathematics Department. Areas of research reflect the wide range of interest present in the staff. Present activity includes research in ergodic theory, graph theory, harmonic functions, shape theory, non-standard analysis, category theory, differential equations, lattice theory, classical analysis, and algebra. A number of research projects have received support from the Naval Academy Research Council.

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## MAXIMAL K-TORI IN SEMISIMPLE ALGEBRAIC GROUPS

Researcher: Assistant Professor Peter P. Andre

Sponsor: Naval Academy Research Council

The purpose of this work is to classify the  $k$ -conjugacy classes of  $k$ -tori in semisimple algebraic groups defined over the field of rational numbers. These tori play a critical role in the structure theory of semisimple algebraic groups. A list of the conjugacy classes of  $k$ -tori will give a measure of the complexity of the parent group.

It has been determined that each such conjugacy class generates an element in the Galois cohomology set in the normalizer of a maximal  $k$ -torus of a semisimple group. It is unknown, at present, whether every element in such a cohomology set will give rise to a conjugacy class. Likewise, every Galois cohomology class in the normalizer of a maximal torus generates a homomorphism from the Galois group in the Weyl group. It is unknown whether every homomorphism arises in this manner.

The above questions have been answered when the underlying field is either the reals or the complex numbers. The rational numbers are sufficiently complicated so that an answer to these questions in groups defined over the rationals will probably be generalizable to other fields.

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## BOUNDARY VALUE PROBLEMS ARISING FROM SWIRLING FLOWS

Researcher: Assistant Professor James M. D'Archangelo

Sponsor: Naval Academy Research Council

The swirling flow problems involve the behavior of fluid occupying the half space above a disc coincident with the horizontal plane and rotating with constant angular velocity about an axis perpendicular to that plane, and the behavior of fluid flow between two rotating coaxial discs some finite distance apart. These are mathematical models of, among other things, propeller blades and the resulting flow.

The objectives of this research have been to learn more about the mathematical nature of the boundary value problems arising from fluid flows, and to answer questions involved in proving existence, uniqueness, and qualitative behavior of their solutions.

So far the research has been concentrated on trying to prove mathematically that a solution exists to the equations modeling the fluid flow for the case where two discs are rotating with constant angular velocities  $\Omega_0, \Omega_1$  respectively. The "shooting technique" was applied,



but this method needs some monotonicity results which do not exist for this problem. The "fixed point method" was recently used by another researcher for the case where  $\Omega_0$  is approximately equal to  $\Omega_1$ , but doesn't seem practical for general  $\Omega_0, \Omega_1$ . Present work on this research project consists of trying to adapt a "boundedness method" to this problem.

It is clear that a new approach or an ingenious adjustment of a known approach will be necessary to solve the swirling flow problems. The researcher will continue work on these problems throughout the next year.

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#### INTERPOLATION AND APPROXIMATION TO SOLUTIONS OF ELLIPTIC PARTIAL DIFFERENTIAL EQUATIONS

Researcher: Assistant Professor Allan J. Fryant

Sponsor: Naval Academy Research Council

The objective of this project is to develop, for certain classes of elliptic partial differential equations, approximation theoretic results analogous to those found in classical theory of polynomial approximation to analytic functions of a single complex variable. Specific goals include the development of analogs of Runge's polynomial approximation theorem, determination of the degree of convergence of the approximants in such theorems, and the uniform approximation of solutions regular on the closure of a region by interpolation to boundary values. The method of investigation involves use of the Bergman-Gilbert-Vehua type integral operators to draw on results from classical complex analysis.

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#### PSEUDOTOPOLOGICAL GROUPS LINEAR SPACES AND ONE-POINT PSEUDOCOMPACTIFICATIONS

Researcher: Assistant Professor Robert A. Herrmann

Sponsor: Naval Academy Research Council

The following problems are being investigated: (a) obtaining a collection  $E$  of one-point pseudocompactifications for a locally pseudocompact space  $X$  which contains, in the pseudotopological sense, a projective maximum and projective minimum; (b) relating this collection to the specific cases of the one-point  $H$ -closure and one-point near compactifications; (c) characterizing the lattice structure

of  $E$  with respect to the projectively larger ordering; (d) determining the conditions under which the cardinality of  $E$  is 1, and (e) applying these results to locally pseudocompact groups and linear spaces.

The  $q$ -monad and the theory of simple topological extensions will be used to investigate (a). The theta and alpha monads will be used to investigate (b). The nonstandard theory of filter bases on meet-semilattices will be used for problem (d). The results obtained from (a), (b), (c), (d) will be used in the investigation of (e).

Preliminary research has indicated that problem (a) should be solvable since these nonstandard procedures have solved the more specific cases of locally  $H$ -closed and locally nearly-compact spaces. The projective minimum should be easily obtained. However, the projective maximum may be more difficult to obtain. It appears that some form of "regularity" is necessary in order to answer (d).

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#### NUMERICAL SOLUTION OF A CLASS OF NON-LINEAR ELLIPTIC PARTIAL DIFFERENTIAL EQUATIONS WITH BIAxIAL SYMMETRY AND CONICALLY SYMMETRIC FLUID FLOWS

Researcher: Assistant Professor Peter A. McCoy

Sponsor: Naval Academy Research Council

A principal objective of this proposal is to utilize the Bergman-Gilbert Integral Operator Method and the Method of Single and Double Layers from the theory of integral equations to approximate solutions for the classical boundary value problems (BVP) of Dirichlet and Neumann of a class of non-linear biaxially symmetric elliptic partial differential equations whose solutions interpret as the dipole approximation of potentials of certain magnetic fields. The axisymmetric and biaxisymmetric Laplace equations are the first order approximations to the class of equations under consideration. By developing new integral operators (and inverse operators) mapping analytic functions of one complex variable onto solutions of the axisymmetric and biaxisymmetric Laplace equations, a simple recursive method for generating approximate polynomial solutions to the BVP assigned on a sphere were devised. Properties of the error in the approximation identifies global solutions from local solutions. The error in the local polynomial approximation of global solutions determines the (possibly infinite) order and (possibly zero) type of the solution. Hence, global error estimates follow. The methods devised are simple, efficient, and extend to BVP assigned on general sets for the axisymmetric problem.

Papers detailing these results have been submitted for publication. Current investigation centers on extension of BVP for biaxisymmetric problem to more general sets and to operators mapping analytic functions of one complex variable onto higher order approximations of the non-linear partial differential equations under study.

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#### THE SPECTRUM OF A GRAPH; GRAPHICAL ENUMERATION

Researcher: Assistant Professor Allen J. Schwenk

Sponsor: Naval Academy Research Council

Two areas in graph theory are being studied. One area is the relationship of graphical properties to the eigenvalues (or spectrum) of the adjacency matrix of the graph. The other area is to apply the enumeration methods of Polya to count new combinatorial structures. The investigation has already produced three articles accepted for publication, whose results are summarized below.

The first article was inspired by Cvetkovic's attempt to find the connected cubic integral graphs. He had displayed twelve such graphs, and had restricted the remaining possibilities to ninety-five potential spectral. In this article we construct the sole graph omitted from Cvetkovic's list and prove that no other exists. The thirteenth graph happens to have the same spectrum as one of the others. This cospectral pair confirms a conjecture of Balaban be being indistinguishable under a certain proposed chemical classification scheme.

In a second article, the analytic methods of Polya are used to determine the asymptotic behavior of the expected number of (unlabeled) trees in a random forest of order  $p$ . Our results can be expressed in terms of the radius of convergence of  $t(x)$  which is the ordinary generating function for trees.

In the third article, necklaces with beads of two colors which are left unchanged both by a reflection as well as by the interchange of the two colors are characterized in terms of their axes of symmetry. This characterization is then used to enumerate them.

In addition to writing these articles, work continues on three manuscripts in various stages of being drafted:

(1) It is proposed to determine the number of labeled graphs in the class  $G$  defined as follows: cycles of all orders  $n \geq 3$  are in  $G$ . If the graph  $G$  is in  $G$  so is the one obtained by identifying any line of  $G$  with a line of a new cycle of any order. The main result of this

paper is the determination of the generating function which enumerates those tree-like graphs with  $p$  points and the number  $q$  of lines as an enumeration parameter.

(2) Consideration of spectra leads to four variations of the usual vertex deletion reconstruction conjecture. One is just the standard problem, which, of course, remains unsolved. Another has a positive resolution due to Tutte. The third version is shown herein to be non-reconstructible. The fourth variation remains open. Corresponding problems with analogous results are found for the edge deletion reconstruction conjecture.

(3) An interesting problem is to enumerate graphs in which the points, the lines, or both are assigned positive or negative signs. There are several associated problems for which these configurations are self-dual with respect to sign change. It is suspected that the solutions to all of these counting problems can be expressed as special cases of one general formula involving the concatenation of the cycle index of the symmetric group with that of its pair group. This counting technique is based on Polya's Enumeration Theorem and the Power Group Enumeration Theorem. The possibilities for asymptotic estimates will also be considered.

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#### PRESENTATIONS OF CHEVALLEY GROUPS OVER INTEGRAL DOMAINS

Researcher: Assistant Professor William P. Wardlaw

Sponsor: Naval Academy Research Council

The purpose of the project is to correctly identify each of the classical matrix groups corresponding to integrally parameterized Chevalley groups of types  $A_n$ ,  $B_n$ ,  $C_n$ , and  $D_n$  and then to translate previously obtained presentations for the integrally parameterized Chevalley groups into matrix form to obtain presentations for the matrix groups. Attempts at generalizing the previously obtained presentations to arbitrary integral domains will also be made.

During the summer the researcher continued study of classical groups, investigated structure of pertinent reflection groups, and rewrote his paper, "Defining Relations for Most Integrally Parameterized Chevalley Groups," to comply with referee's comments. While preparing the bibliography for the latter, he discovered a scholarly paper which overlapped the researcher's paper and precluded its submission without extensive revision. During the academic year, work on this project has been limited to study of algebraic groups in faculty seminar.

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## AMENABLE ERGODIC GROUP ACTIONS AND APPLICATIONS

Researcher: Assistant Professor Robert J. Zimmer

Sponsor: Naval Academy Research Council

The main developments follow from the application of cohomological techniques. Two problems have been investigated: first, the development of a notion of amenable ergodic group action, parallel to the corresponding notion of amenability in group theory, with applications to random walks, Von Neumann algebras, and Poincare flows; second, the ergodicity of the restriction of an ergodic action of a group to a subgroup.

It has been shown that the classical construction of factors from ergodic transformation groups due to Murray and Von Neumann and later modified by Krieger yields a hyperfinite factor if and only if the corresponding ergodic equivalence relation is amenable. This generalizes a known result for the Von Neumann algebra generated by the regular representation of a discrete group.

In the case of the second problem, it has been shown that every properly ergodic action with quasi-invariant measure of a simple connected, non-compact Lie group is still ergodic when restricted to a lattice subgroup. This result is still true for simple, non-compact, connected algebraic groups over local fields of characteristic zero. For nilpotent Lie groups, ergodicity of the restriction to the commutator subgroup implies ergodicity on any lattice. These results can be applied to give new criteria for the recurrence of random walks on homogeneous spaces.

This material will appear in a forthcoming series of papers.

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## QUESTIONS IN ERGODIC THEORY AND STOCHASTIC PROCESSES

Researcher: Assistant Professor Robert J. Zimmer

Sponsor: Naval Academy Research Council

The objective of this project is to study various questions related to the interconnections of stochastic processes, ergodic theory, and group theory. For example:

(1) Identify those groups admitting ergodic or recurrent processes with various classes of stationary increments.

(2) Classify and give new constructions for cocycles of ergodic actions. This should have applications to non-linear prediction theory.



(3) Generalize Ambrose's theorem on the representation of flows to actions of more general groups.

(4) Study the relationship between an ergodic action and the von Neumann algebra associated to it.

(5) Develop a Lie algebra for ergodic group actions.

The notion of an amenable ergodic group action which seems likely to have diverse applications has been developed. To date applications concerning the limiting behavior of random walks, generalizations of Ambrose's theorem, ergodicity of skew products and stochastic processes with stationary increments, and hyperfinite von Neumann algebras have been presented. In a different direction, cocycle techniques have also been applied to study the relationship between certain symmetry groups and their lattice subgroups.

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## CLOSURE OPERATORS ON FINITE SETS

Researcher: Assistant Professor W. Russell Belding

A closure operator  $c$  acting on a set  $X$  is a map from the set of subsets of  $X$ ,  $P(X)$  to  $P(X)$ , satisfying the following properties: for  $A, B$  subsets of  $X$  (1)  $A \subseteq c(A)$ , (2)  $c(A) = cc(A)$  and (3)  $A \subseteq B$  implies  $c(A) \subseteq c(B)$ . Closure operators are common in algebraic and geometric structures. The closed sets are those of the form  $c(A)$  and a basis for a closed set  $c(A)$  is a set  $Y \subseteq c(A)$  such that  $c(Y) = c(A)$ ,  $Y$  spans  $c(A)$ ; and if  $Z$  is a proper subset of  $Y$  then  $c(Z)$  is a proper subset of  $c(Y)$ ,  $Y$  is independent. Closure operators may possess the exchange property: if  $x \notin A$  and  $x \in c(A \cup \{y\})$  then  $y \in c(A \cup \{x\})$ . It is known that for a closure operator with the exchange property, each closed set has a basis and two bases for the same closed set have the same cardinality.

In special contexts where the closure operator does not have the exchange property, it has been shown that closed sets which have bases have the property that two bases for a given closed set have the same cardinality.

The problems under investigation are thus: (1) for a finite set  $X$ , give characterizations of those closure operators without the exchange property but for which each closed set has a basis and (2) give characterizations of those closure operators whose bases for given closed sets have the same cardinality.

The collection of closure operators on a set forms a lattice and the first approach to these problems is to attempt such characterizations as the location of the closure operator in this lattice.

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## A STUDY OF MODULAR FIELD EXTENSIONS

Researcher: Assistant Professor Richard L. Davis

This study investigates modular field extensions with emphasis placed upon the extensions arising from the action of higher derivations on a field. A higher derivation  $(d_0, d_1, \dots)$  in  $K$  is a sequence, finite or infinite, of endomorphisms of the additive structure of  $K$  with the additional properties that  $d_0$  is the identity mapping and  $d_k(ab) = \sum \{d_i(a)d_j(b) \mid i+j=k\}$  for all  $a$  and  $b$  in  $K$ . The intersection of the kernels of the mappings having positive subscript is a subfield  $k$  of  $K$  and furthermore  $K/k$  is a modular field extension; that is,  $K^p$  and  $k$  are linearly disjoint over their intersection for all  $r$  ( $p \neq 0$  is the characteristic of the field).

The extensions  $K/k$  in which  $k$  is obtained in the above manner from an infinite higher derivation are examined and characterizations of the subfields  $k$  are sought. In an earlier work, it was shown that these subfields are precisely the fields over which  $K$  is separable and

$\bigcap_n K^{p^n}(k) = k$ . A characterization in more conventional terms would be desirable. One conjecture is that the intersection requirement could be replaced by the requirement that  $k$  be algebraically closed in  $K$ . The approach used is to construct a higher derivation in  $K$  by defining it on a  $p$ -basis for  $K/k$  in such a way that it moves all field elements between  $k$  and  $K$ . An alternate characterization in the most general setting has not yet been obtained.

A related problem concerns the structure of the group of infinite higher derivations in the field  $K$ . A characterization of the Galois sub-groups is sought. It has been found that if a subgroup is to be a Galois subgroup, then the factors of its lower central series must be equal and must be restricted  $p$ -Lie algebras. It is hoped that a theory analogous to that for groups of finite higher derivations might be developed.

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#### ASYMPTOTIC BEHAVIOR OF SOLUTIONS OF MULTIVALUED DIFFERENTIAL EQUATIONS VIA CONTINUOUS SELECTIONS

Researcher: Assistant Professor James P. Foti

Let  $F$  and  $G$  be continuous set-valued mappings (in the sense of C. Berge and E. Michael) for  $\mathbb{R}^d$  and  $\mathbb{R}^{d+1}$  (finite dimensional Euclidean spaces), respectively, to the non-empty compact strictly-convex subsets of  $\mathbb{R}^d$  such that all solutions of the contingent equation  $x' \in F(x)$  approach zero at  $t \rightarrow \infty$ . The author defines the concept of a diminishing set-valued function and establishes that for each member  $\phi$  of a certain family of classical solutions of the perturbed equation  $x' \in F(x) + G(t, x)$  there corresponds an ordinary differential equation  $x' = f(x) + g(t)$  satisfied by  $\phi$ . Moreover,  $f$  and  $g$  are continuous selections for  $F$  and  $G^*$ , respectively, where  $G^*(t)$  is defined to be the intersection of the sets  $G(t, \phi(t))$  and  $(\phi'(t) - F(\phi(t)))$ . If  $G$  is bounded and diminishing, then results from ordinary differential equations guarantee that  $\phi$  approaches zero at  $t \rightarrow \infty$  provided that  $\lim (\phi(t) - g(t))$  exists as  $t \rightarrow \infty$ .

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## NONSTANDARD IMPLICATION ALGEBRAS

Researcher: Assistant Professor Robert A. Herrmann

In 1961, Professor James C. Abbott and P. R. Kleindorfer of the U.S. Naval Academy discovered a new characterization for Boolean algebras. The basic structure is the implication algebra. In the present study, this structure is investigated in the context of non-standard join semi-lattices, with or without units, lattices, and Boolean algebras. It is shown that these structures can all be represented by classes of  $\star$ -finite subsets of  $\star I$ . Then by studying general ideal theory, it is shown that there exists a "universal" set  $M$  for construction of representations for disjunctive join semi-lattices. The disjunctive join semi-lattices include the implication algebras. It turns out that the implication algebra yields the most interesting representation results. These results differ considerably from those which have been previously obtained since they are all relative to a common carrier  $P(M)$  and thus can be easily compared.

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## STATISTICAL PATTERN RECOGNITION

Researcher: Associate Professor John S. Kalme

Pattern recognition concerns adaptive and analytic techniques for processing large amounts of data, the extraction of useful information to reduce the data, and classification of data. One compares the information derived from input signals with similar data derived from known sample patterns, called prototypes. The specification of prototypes is accomplished adaptively utilizing a learning algorithm. In applications involving time series data, particularly physiological signals such as electroencephalographic detection of specific frequencies and correlation between frequencies are some features to be extracted. The principal tools of analysis involve digital filters, multivariate statistical analysis, QR algorithms for finding eigenvalues of symmetric matrices after tridiagonalization, principal components analysis, and statistical discriminant analysis to generate features. Computer programs being developed for pattern recognition will be combined with programs for the statistical analysis of time series spectra, which the investigator developed with 1975-1976 Trident Scholar S. Rahe, to analyze and classify various time series spectra, especially EEG data.

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## EXTREMAL PROPERTIES OF REAL BIAXIALY SYMMETRIC POTENTIALS

Researcher: Assistant Professor Peter A. McCoy

This investigation is concerned with a set  $B$  of well-defined real biaxially symmetric potentials which are regular in the open unit sphere about the origin in  $E^{2p}(p>1)$ . On expressing each potential in an appropriate infinite Fourier series, three problems arise concerning  $B$  and subset  $B_*$  whose members have the first  $m+1$  coefficients specified.

(1) The infimum of each potential in  $B$  is evaluated as the limit of a monotone sequence of eigenvalues of Toeplitz Matrices which are evaluated algebraically from the Fourier coefficients.

(2) The unique extremal function in the set  $B_*$  and eigenvalue are determined for which the eigenvalue equals the infimum of the extremal function which in turn equals the supremum over set  $B_*$  of the infima of its members.

(3) Necessary and sufficient conditions are determined from the Fourier coefficients so that a potential in  $B$  is non-negative. These solutions are developed from operators related to those found in previous NARC funded research which employed Koornwinder's LaPlace type integral for Jacobi polynomials, along with applications of Hadamard's Methods of Ascent and Descent to the Caratheodory-Fejer and Caratheodory-Toeplitz problems which focus on the properties of harmonic functions in the plane.

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 $H^p$  SPACES ON THE POLYDISC AND ON SEMIGROUPS

Researcher: Assistant Professor Howard L. Penn

The objective of this work is to investigate the behavior of  $H^p$  functions on the polydisc and on semigroups. Two specific significant results have been obtained. First, a constructive method of replacing a measure defined on the polydisc with one defined on the torus has been obtained such that the integral of any function in  $H^p$  is the same with respect to the two measures. Second, if  $f$  is a function in  $H^p$  of a semigroup then  $f$  has an inner-outer factorization if and only if  $\log|f|$  has its Fourier series vanish off the semigroup together with its negative. The direction that the investigation is presently taking is that of determining whether the property:  $f \in H^q(U^n)$  and  $f \cdot p_n$  dense in  $H^p(U^n)$ , where  $p_n$  are the polynomials and  $p < q$ , implies  $f \cdot p_n$  dense in  $H^q(U^n)$ .

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## FUGLEDE COMMUTATIVITY THEOREM AND OPERATOR TOPOLOGIES

Researcher: Assistant Professor Donald D. Rogers

Considerable work has been done lately by several mathematicians on generalizing the well-known Fuglede commutativity theorem for normal operators. One direction of research is concerned with various asymptotic generalizations of the original Fuglede statement. These generalizations, however, are usually stated as results in  $C^*$ -algebras. Generalizations of a non- $C^*$ -algebra character have been generally unexamined. The current project is concerned with generalizations of the Fuglede theorem of a more topological nature that are apparently not obtainable by  $C^*$ -algebra methods. These include various asymptotic generalizations involving the strong or weak operator topologies. Areas in which generalizations fail to exist are also being studied.

A related investigation involves generalizations of the Fuglede theorem using hyponormal or dominant operators. It is planned to determine whether results in this direction can be significantly generalized to asymptotic and topological statements about operators.

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## SHAPE THEORY

Researcher: Assistant Professor Thomas J. Sanders

The objective is to find applications of the shape theory, which is a branch of mathematics in the areas of topology and algebraic topology, and to further develop the subject. In particular, information is sought about the shape of a regularly movable space  $X$  from an associated direct sequence  $X^*$  and its direct limit  $X^\infty$ .

By embedding  $X$  in Hilbert Cube  $Q$ , or another appropriate absolute retract, one can obtain an inclusion ANR sequence associated with  $X$ . Obtaining and studying the associated direct sequence in some specific example, in particular the "sin  $1/x$  - continuum," should give an idea as to the relationships that may exist between  $X$  and  $X^\infty$ . It is also planned to look at Borsuk's FANR-sets and their relationship to the direct sequence  $X^*$ .

The concept of movable has been an interesting productive topic since it was noted by Borsuk. Some mathematicians believe that regular movable may be a concept that will help answer some open questions in shape theory. One such question is: When can one show that the union of two FANR set is a FANR set? It is hoped that added information from  $X^*$  and  $X^\infty$  may help answer this question.

A direct sequence from the inclusion ANR-sequence has been obtained such that each member is deformable into its successor inside its predecessor. A specific example has not yet been studied in detail.

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#### SOME ENUMERATION PROBLEMS IN GRAPH THEORY

Researcher: Assistant Professor Allen J. Schwenk

The completion of research efforts begun before joining the faculty of the Naval Academy has culminated in one article which has appeared during the past year and three others now accepted for publication. The latter efforts are summarized below.

(1) In a boolean graph, every automorphism has order 1 or 2. A minimal boolean graph with  $p$  points has the smallest possible number of lines. A linear forest has paths as its components. Exact formulas are found for the number of minimal boolean linear forests with  $p$  points and the number of lines in such a format.

(2) Let  $Z(S_n; f(x))$  denote the polynomial obtained from the cycle index of the symmetric group  $A(S_n)$  by replacing each variable  $s_i$  by  $f(x^i)$ . The limit of  $Z(S_n; f(x))/x^{kn}$  is evaluated as  $n$  increases without bound.

This limit is used to estimate the probability (for  $n$  and  $p$  both large) that a point chosen at random from a random  $p$ -point tree has degree  $n + 1$ . These limiting probabilities are independent of  $p$  and decrease geometrically in  $n$ , contrasting with labeled limiting probabilities of  $1/n!e$ .

In order to prove the main theorem, an appealing generalization of the principle of inclusion and exclusion is presented.

(3) It is well known that the number of closed walks of length  $n$  is simply the  $n$ 'th moment of the adjacency matrix. Similar spectral expressions are found for unrestricted (either open or closed) walks, and also for walks from any specified starting set of points to another set of terminal points. Knowledge of the number of walks in  $G$  may be applied to find the spectrum of the complement of  $G$ . In conclusion, cyclic and dihedral equivalence relations are defined for closed walks and Burnside's Lemma is used to enumerate the number of equivalence classes of both types.

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BAKER, Robert L., Assistant Professor, "Car-Following Models," 1976 Mathematical Association of America College Faculty Workshop at Cornell University.

LaPlace transform techniques are used to study the differential equations and differential-delay equations of car-following models. A heuristic discussion of stability is included, with mathematical details left to an appendix. Steady-state equations for flow versus concentration are derived using elementary integration, and their significance in relation to other traffic theories and empirical results is discussed.

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BAKER, Robert L., Assistant Professor, "Five Nautical Models," 1976 Mathematical Association of America College Faculty Workshop at Cornell University.

A collection of five loosely related models collected by a panel of officers at the United States Naval Academy was discussed. Techniques used are from the single variable differential and integral calculus. Topics covered and main techniques are: estimating distance to horizon (trigonometry), rendezvous of two ships (circles), submarine detection and long range navigation (ellipses and hyperbolas), submarine hunt (polar coordinates and exponential function), and satellite surveillance (integrals).

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D'ARCHANGELO, James M., Assistant Professor, and Peter A. McCOY, Assistant Professor, "Value Distribution of Biaxially Symmetric Harmonic Polynomials," Canadian Journal of Mathematics, Vol. 28, (August 1976), 769-773.

It is known that any biaxially symmetric harmonic polynomial (BAHP) of degree  $2n$  can be represented in the form  $H(u,v) = \sum_{k=0}^n A_k R_k^2 P_k^{(\alpha,\beta)}(\cos 2\theta)$  where  $\alpha, \beta > -1/2$ . Until now, the lack of a suitable representation for the Jacobi polynomials  $P_k^{(\alpha,\beta)}$  has made it difficult to determine a value distribution for BAHP's analogous to the value distribution for axisymmetric harmonic polynomials defined by Morris Marden using the Whittaker Formula for the Legendre polynomials. However, Tom Koorwinder's new LaPlace-type integral representation for Jacobi polynomials now allows us to determine information about the value distribution for BAHP's.

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FRYANT, Allan J., Assistant Professor, "Growth and Complete Sequences of Generalized Axisymmetric Potentials," Journal of Approximation Theory, 19, (1977).

Using Gilbert's  $A_{\mu}$  integral operator, the growth of entire solutions of the generalized axisymmetric potential equation is considered. Growth of solutions is related to the growth of their  $A_{\mu}$  associates, the concepts of proximate order and type with respect to proximate order are introduced, and these measures of growth are characterized explicitly in terms of the ultra-spherical harmonic coefficients. Necessary and sufficient conditions for a generalized axisymmetric potential to be of regular or perfectly regular growth are obtained in terms of the function's coefficients in its spherical harmonic expansion. Application is made to generating (in a constructive manner) complete sequences of solutions of the partial differential equation from single entire solutions.

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HERRMANN, Robert A., Assistant Professor, "The  $Q$ -Topology, Whyburn Type Filters and the Cluster Set Map," Proceedings of the American Mathematical Society, 59, (1976), 161-166.

Nonstandard topology and the  $Q$ -topology are used to characterize normal, almost-normal, regular, almost-regular, semi-regular spaces. The cluster (resp.  $\theta$ -cluster) set relation is used to characterize regular, almost-regular (resp. strongly-regular) spaces. The Whyburn (resp. Dickman) filter bases are characterized and it is shown that the cluster (resp.  $\theta$ -cluster) set relation restricted to the domain of the Whyburn (resp. Dickman) filter bases is an essentially continuous (resp. strongly  $\theta$ -continuous) map if the space is Hausdorff (resp. Urysohn).

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HERRMANN, Robert A., Assistant Professor, "The  $\theta$  and  $\alpha$  Monads In General Topology," Kyungpook Mathematical Journal, 16 (1976), 231-241.

Since it was first introduced by A. Robinson, the point monad had proved to be a useful device for characterizing and studying numerous topological concepts. Two new point monads are examined, the  $\theta$ -monads and  $\alpha$ -monads, which are capable of similarly characterizing the various concepts associated with quasi-H-closed, nearly compact, semiregular, regular, almost-regular, Hausdorff, Urysohn spaces as well as  $\theta, \delta$ -cluster points,  $\theta, \delta$ -convergence theory,  $\theta$ -continuity, almost continuity, among others. Indeed, the  $\theta$ -monad shall play an important role in the approach to H-closed, Urysohn spaces and unique cluster point theory. The

relations between the  $\theta, \alpha$ -monads and the monad of Robinson will be investigated to show how their interaction not only characterizes almost-regular, semiregular, and regular spaces but allows interesting results about almost-open, weakly-open and open maps to be deduced.

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HERRMANN, Robert A., Assistant Professor, "Nonstandard Quasi-Hausdorff, Urysohn and Regular-Closed Extensions," Bulletin Institute of Mathematics, Academia Sinica, 5(June 1977), 13-25.

The nonstandard theory of (filter base) monads on a meet-semilattice is used to construct, as subsets of an arbitrary enlargement, quasi-H-closed, quasi-Urysohn-closed, and quasi-regular-closed extensions for an arbitrary space  $X$ . These extensions have many of the more important properties. These included the projective maximum, open combinatorially embedded,  $T_2$  except for  $X$ , Urysohn except for  $X$  and a semi-regular property, as well as the existence of continuous extensions of the identity. Since the elements of the space  $X$  and these extensions are of the same set-theoretic type, their existence tends to strengthen the viewpoint that the enlargement is the appropriate model for such investigations.

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McCOY, Peter A., Assistant Professor, "On the Zeros of Generalized Axially Symmetric Potentials," Proceedings of the American Mathematical Society, Vol. 61, No. 1, November 1976.

Generalized axially symmetric potentials may be expanded as Fourier-Jacobi series in terms of the complete system  $f^k C_k^{n/2-1}(\cos \theta)$  on axisymmetric regions  $\Omega \subset E^n (n \geq 3)$  about the origin. The values of these potentials are characterized by the nonnegativity of sequences of determinants drawn from the Fourier coefficients in a manner analogous to the characterization of the values of analytic functions of one complex variable by the theorems of Caratheodory-Toeplitz and Schur.

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ROGERS, Donald D., Assistant Professor, "On Proximinal Sets of Normal Operators," Proceeding of the American Mathematical Society, 61 (November 1976), 44-48.

This paper answers a long-outstanding question in the theory of linear operators on infinite-dimensional Hilbert spaces (a generalization of the usual linear transformations encountered in



linear algebra) by showing that an arbitrary linear operator need not have a nearest point from the set of normal operators; approximation problems regarding other sets of normal operators are also considered and some are answered completely.

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SANDERS, Thomas J., Assistant Professor, "Compactly Generated Shape Theories," Fundamenta Mathematicae 93 (1976), 37-40.

For locally compact metric spaces, Borsuk's weak extension of shape to metric spaces and compactly generated shape are equivalent.

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SCHWENK, Allen J., Assistant Professor, co-author, "On Tactical Configurations with no Four-Cycles," Journal Combinatorial Theory, A20 (1976), 371-374.

An improved lower bound is given for the band sizes of tactical configurations of rank exceeding two having no 4-cycles. This bound is applied to find an optimal configuration with certain specified parameters. A formula is given for the maximum number of cycle types one must examine to demonstrate that a rank  $r$  configuration has no  $g$ -cycle. This result which has appeared in the researcher's earlier work as the number of types of closed walks, answers a question of Longyear.

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ZIMMER, Robert J., Assistant Professor, "Extensions of Ergodic Group Actions," Illinois Journal of Mathematics, 20(1976), 373-409.

The discrete spectrum theory of ergodic transformations due to Halmos and Von Neumann and extended to group actions by Mackey is generalized to the case of extensions of ergodic group actions. In particular, the structure theorem and existence-uniqueness theorem are generalized. As background, some general results on cocycles taking values in compact groups are developed.

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ZIMMER, Robert J., Assistant Professor, "Ergodic Actions with Generalized Discrete Spectrum," Illinois Journal of Mathematics, 20(1976), 555-588.

A proof is given for a measure theoretic analogue of the Furstenberg structure theorem for minimal distal flows, showing that

generalized discrete spectrum is equivalent to the existence of a separating sieve. Applications are presented to affine transformations on abelian groups and to quasi-discrete spectrum.

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ZIMMER, Robert J., Assistant Professor, "Random Walks on Compact Groups and the Existence of Cocycles," Israel Journal of Mathematics, 26(1977), 84-90.

Certain skew products in ergodic theory are shown to be isomorphic to the shifts defined by random walks. This yields the existence of cocycles of hyperfinite actions whose range is an arbitrary compact group.

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ZIMMER, Robert J., Assistant Professor, "Compact Nilmanifold Extensions of Ergodic Actions," Transaction of the American Mathematical Society, 223(1976), 397-406.

Ergodic and relative spectral properties are determined for extensions of dynamical systems defined by cocycles into nilpotent Lie groups. Results for flows on nilmanifolds are generalized to extensions by nilmanifolds. The techniques involved are those from the theory of unitary group representations and ergodic theory.

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PRESENTATIONS

MATHEMATICS DEPARTMENT

BAKER, Robert L., Assistant Professor, "The Past, Present, and Future of Computer Calculus at the U.S. Naval Academy." Paper read at the Washington-Annapolis-Baltimore Area Symposium on Computer Education, Annapolis, Maryland, May 1977.

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D'ARCHANGELO, James M., Assistant Professor, "On the Whittaker Differential Equation and Laplace Transforms." Paper read at regional meeting of the American Mathematical Society, New York City, New York, 14-15 April 1977.

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FRYANT, Allan J., Assistant Professor, "Growth and Complete Sequences of Generalized Axisymmetric Potentials." Paper read at the 80th Summer meeting of the American Mathematical Society, Toronto, Canada, 26 August 1976.

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FRYANT, Allan J., Assistant Professor, "Interpolation and Approximation of Generalized Axisymmetric Potentials." Paper read at regional meeting of American Mathematical Society, New York City, New York, 14 April 1977.

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HARTIG, Donald G., Assistant Professor, "Pseudocompactness and Local Connectedness In Completely Regular Spaces." Paper read at 83rd Annual meeting of American Mathematical Society, St. Louis, Missouri, 26-30 January 1977.

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HERRMANN, Robert A., Assistant Professor, "Perfect Maps and Convergence Spaces." Paper read at 83rd meeting of the American Mathematical Society, St. Louis, Missouri, 28 January 1977.

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HERRMANN, Robert A., Assistant Professor, "There are No Unusual Normal Vector Spaces in which Bounded Subsets are Basically Bounded." Paper read at regional meeting of Mathematical Association of America, University of Maryland, 30 April 1977.

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PRESENTATIONS

MATHEMATICS DEPARTMENT

McCOY, Peter A., Assistant Professor, "External Properties of Real Biaxially Symmetric Harmonic Functions." Paper read at 83rd meeting of the American Mathematical Society, St. Louis, Missouri, 28 January 1977.

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McCOY, Peter A., Assistant Professor, "External Properties of Real Axially Symmetric Harmonic Functions in  $E^3$ ." Paper read at regional meeting of American Mathematical Society, Columbia, South Carolina, November 1976.

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MOULIS, Edward J., Assistant Professor, "Generalizations of the Robertson Functions." Paper read at regional meeting of the American Mathematical Society, New York, 14 April 1977.

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POLLAK, Richard A., Assistant Professor, "Performance Evaluation: A Step Towards Accountability." Paper read at Annual meeting SIGUCC Association for Computing Machinery, November 1976.

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POLLAK, Richard A., Assistant Professor, co-author, "Computer Applications as Part of Instruction: Some General Notions and Examples." Paper read at the American Institute of Biological Sciences, 1976.

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WARDLAW, William P., Assistant Professor, "Computer Aided Instruction In Abstract Algebra." Paper read at the Washington-Annapolis-Baltimore Area Symposium on Computers in Education, Annapolis, Maryland, May 1977.

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ZIMMER, Robert J., Assistant Professor, "Restricting Lie Group Actions to Lattice Subgroups." Paper read at regional meeting of American Mathematical Society, Evanston, Illinois, 15-16 April 1977.

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ZIMMER, Robert J., Assistant Professor, "On Skew Products In Ergodic Theory." Paper read at regional meeting of American Mathematical Society, University of Connecticut, 30 October 1976.

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PRESENTATIONS

MATHEMATICS DEPARTMENT

ZIMMER, Robert J., Assistant Professor, "Ergodic Theory and Group Representations." Colloquium Lecture, Western Michigan University, Kalamazoo, Michigan, 14 April 1977.

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ZIMMER, Robert J., Assistant Professor, "Ergodic Theory and Unitary Representations." Special lecture delivered at Wesleyan University, Middletown, Connecticut, March 1977.

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## OCEANOGRAPHY DEPARTMENT

Commander John G. McMillan, USN, Chairman

Research in the Oceanography Department covers a wide range of areas in the environmental and oceanic sciences reflecting the many levels of expertise held by the civilian and military Department faculty as well as those in the Oceanography major. All of the civilian faculty are engaged in either individual, group research, or research management projects supported both by external and internal sources. Qualified undergraduate students are encouraged to conduct research in specific areas under faculty supervision. Research efforts in those areas relevant to the estuarine sciences are strongly supported by both an 80-foot, scientifically-equipped vessel, a small runabout, and extensive laboratory facilities.

Specific areas of research activity by the Department include but are not limited to sedimentation processes and properties, submarine geology, oceanic eddy processes, estuarine pollution, estuarine ecology, and marine optics. Many of these efforts involve both faculty and students.

This year has been one of transition with the departure of several of the military faculty, the completion of projects noted in the 1975-1976 report, and the arrival of new civilian and military faculty. Preliminary work in several new research areas, predominantly biological, are in progress.

Support for active research in the Oceanography Department has been provided by the Environmental Protection Agency, the Office of Naval Research, the United States Geological Survey, the Chief of Naval Development, the Naval Academy Research Council, and other sources.

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## AN EVALUATION OF MESOSCALE OCEANIC EDDY STATISTICS FROM BOTH HISTORICAL AND SHIPS OF OPPORTUNITY EXPENDABLE BATHYTHERMOGRAPH DATA

Researcher: Lieutenant Commander H. Lee Dantzler, Jr., USN

Sponsor: Naval Ocean Research and Development Activity (Code 410)

Expendable bathythermograph records are being used to provide estimates of the potential energy associated with vertical displacements in the tropical and subtropical North Atlantic thermocline. The geographic variations in potential energy help identify both those ocean areas which may be associated with recurring eddy activity and the magnitude of that activity. The results to date indicate maximum variability in and near the boundary current regimes along the perimeter of the subtropical gyre, and in the vicinity of major topographic features such as the Mid-Atlantic Ridge and the Antillean island arc. Should this variability in thermocline depth arise from ocean eddies, the formation of these eddies may be both dynamically and topographically related. Ships of opportunity are being used both to provide well resolved data records within the potential energy maxima areas and to augment the existing data in the data-poor regions of the North Atlantic. Six ships operating both in the eastern and western basins have been provided with expendable bathythermograph probes and some 20,000 kilometers of track data resolved to 40 kilometers will have been obtained by July 1977. These data are confirming that a significant portion of the variability found in the historical data is eddy related.

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## DISTRIBUTION, ORIGIN AND MILITARY SIGNIFICANCE OF INTERGLACIAL REEFS AND CEMENTED SEDIMENTS ON THE CONTINENTAL SHELF

Researcher: Associate Professor Douglas W. Edsall

Sponsor: Naval Academy Research Council

An increase in oceanic surface water temperatures at the beginning of the most recent interglacial interval has been demonstrated. Some researchers suggest that this increase must correspond with times of low sea level. Furthermore, studies of deep sea sediments have shown that oceanic surface temperatures determine the latitudinal position of the boundary between the carbonate/non-carbonate sediments along the east coast of the United States. This boundary is known to have shifted latitudinally in response to long-term climatic changes in the Tertiary, but said boundary could also have been shifted by short-term fluctuations in sea water temperatures in the Quaternary. Northward shifts would be associated with the beginning of the interglacial periods. The carbonate/non-carbonate boundary for the present interglacial, which began at the end of the Wisconsin glaciation, would therefore be found in Holocene sediments at higher latitudes than those in today's oceans. In addition,

the depth would be comparable with those of sea level at that time, up to 140 meters deeper. These earlier formed interglacial age carbonate materials would be found in higher latitudes, above which carbonate materials are being deposited today. They would occur as algal reefs or as cemented sediments.

These reef-life features and cemented sediments have been located in two ways: (1) indirectly, by examining precision depth recorder and seismic reflection profiler records from the continental shelf; and (2) directly, by examining bottom samples from appropriate sites. Based on these data and the literature, maps have been prepared showing the distribution of reefs, cemented sediments and other shoreline features. For the first time it is possible to show the type, extent, and depth of the various shoreline features associated with low stands of sea level during the Pleistocene for the entire east coast of the United States. Analysis of these data suggest that published sea level curves may be in error due to the locating effects of ice on the coastal areas north of the New York Bight. The naval applications of this study are far reaching and will be examined in detail.

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#### ANALYSIS OF HIGH-RESOLUTION SEISMIC REFLECTION RECORDS FROM THE SOUTH-EAST GEORGIA EMBAYMENT

Researcher: Associate Professor Douglas W. Edsall

Sponsor: United States Geological Survey, Woods Hole, Massachusetts

This study involved the interpretation of over 5,000 miles of high-resolution seismic reflection records from the South-East Georgia Embayment. Two weeks were spent at sea collecting the geophysical data. The remainder of the time was spent in the analysis of the data. These data were collected for the Bureau of Land Management's OCS program. Utilizing COST well data obtained by the Survey, it was possible to date the acoustic-stratigraphic sequences observed in the sparker records.

Results of this work have been presented to representatives of the Bureau of Land Management in New Orleans, to a meeting of state geologists in Atlanta and a regional meeting of the staff of the Office of Marine Geology in Woods Hole.

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## PHYTOPLANKTON DYNAMICS OF THE WESTERN NORTH ATLANTIC

Researcher: Assistant Professor John W. Foerster

Sponsor: Sea Education Association, Woods Hole, Massachusetts

The principal investigator served as Head of Marine Science and Senior Scientific Investigator aboard the R/V Westward during the 1977 cruise. This ship's cruise was designed to provide educational and research opportunities for the participants. The research aspects are focused on obtaining information concerning the microbiological and chemical/physical relationships in the Gulf Stream and Sargasso Sea. Data on the summer productivity levels of phytoplankton will be compared with the results of other investigators.

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## AN INVESTIGATION OF SELECTED DREDGING PROBLEMS IN U.S. NAVY-CONNECTED HARBORS

Researcher: Professor John F. Hoffman

Sponsor: Naval Facilities Engineering Command (Code 032D)

The research undertaken in this grant was divided into three parts. One part concerned new dredging methods of low capacity where use is confined to a small area such as a pier slip. The second part concerned evaluating the problem of accretion of sediments in Pier 12 at the U.S. Naval Base at Norfolk, Virginia, and the problem of the disposal of dredge spoil resulting from channel deepening in the Thames River at the New London Submarine Base. The third part was to outline a lecture on dredging methods and problems for use at the U.S. Navy Civil Engineering School at Port Hueneme, California. The first two parts of the research are discussed, briefly, below.

Owing to the expense and awkwardness of utilizing the conventional methods of dredging (hopper dredge, pipeline dredge, bucket and barge) for maintaining pier slips, it is desirable to use a more convenient and more economical method: (1) agitation dredging, (2) Pneuma system of dredging, (3) dredging system utilizing educators, (4) Dixie dredge, (5) Mudcat dredging system, and (6) the Marconoflo slurry system.

The fouling problem appears to be threefold:

a. biofouling of condenser tubes by masses of marine organisms that have been broken loose at other parts of the harbor by mechanical action (presumably as the result of storms) and transported to Pier 12 area by currents;

b. fine-grain material previously deposited at the bottom of the berth being picked up and carried into the condenser tubes; and

c. erosion of the submarine walls of the relatively narrow berth by the screws of a carrier when the carrier is entering the berth at an angle to the pier.

Evaluation is in progress.

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AN INVESTIGATION OF THE CORRELATION BETWEEN ATLANTIC-TROPICAL CYCLONE  
SEASONAL TRACKS AND THE FOLLOWING WINTER SEVERITY OF THE EASTERN U.S.A.

Researcher: Midshipman 1/C Michael F. Calfee

Adviser: Lieutenant Commander Richard B. Brodehl, USN

The purpose of this research is to determine if there is any correlation between average seasonal longitude of recurvature of tropical Atlantic hurricanes and the severity of the following winter in the eastern United States. Ten years of storm tracks were used, 1967 through 1976. Little significant correlation was found for this 10 year period, but some indication of better correlations may be found by using other criteria than average recurvature longitude. Further and more encompassing research was recommended.

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ORIGIN OF FLUVIAL FEATURES ON MARS

Researcher: Midshipman 1/C Albert R. Hochevar

Adviser: Associate Professor Douglas W. Edsall

Midshipman Hochevar worked as a Viking Intern during the month of August 1976 at the Jet Propulsion Laboratory in Pasadena, California. He was a member of the LIFT team (Lander Imaging Flight Team) working under Dr. T. Mutch. He returned from JPL with a photo mosaic of the Chryse Basin area, the Viking I landing site, bounded by Latitudes 17° to 27° North and Longitudes 29° to 57° West. From this mosaic a geological map was produced. The major features mapped were craters, wrinkle ridges, channel features and mounds. A sequence of cratering, fluvial activity and volcanism can be observed from the resulting map; however, the sequence of events can not be determined without elevation data. This data has not been released after more than two months of unnecessary delay. Upon receipt of this data a discussion of the sequence of events will be provided to accompany the map. It can be stated at this time that Mars, however, has undergone nearly all of the geological processes that have occurred and are occurring on earth today. The major difference is that Mars has been a geologically inactive planet, except for cratering, for a much longer period of time, such that we are looking at a similar stage in the earth's creation as it might have looked some several billions of years ago.

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THE EFFECT OF WATER AND COPPER RICH SEDIMENTS OF THE CHESAPEAKE BAY ON  
THE AMERICAN OYSTER-CRASSOSTREA VIRGINICA

Researcher: Midshipman 1/C Richard L. Marcantonio

Adviser: Professor John F. Hoffman

The purpose of this investigation was to determine whether or not the tissues of oysters living in sediments contaminated by copper compounds of low solubility will become contaminated by the copper.

Hatchery-reared stocks of cultchless oysters were set out in various locations in the Chesapeake Bay and sampled periodically. These oysters, along with native oysters, were analyzed for their copper concentrations. Water and sediment sampled simultaneously from these areas were analyzed for copper and comparisons of these concentrations were made with the copper concentrations within the tissues of the oysters.

The results indicate that: (1) copper concentrations in stock oysters living in the same area as native oysters, were lower than those in native oysters, (2) copper concentrations in oysters from areas of high copper concentrations in the sediment were higher than for other areas, (3) copper concentrations in oysters from areas where high copper concentrations were in the water column were not very different from the copper concentrations in oysters from areas where low copper concentrations were in the water column.

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DANTZLER, H. Lee, Jr., Lieutenant Commander, USN, "Geographic Variations in Intensity of the North Atlantic and North Pacific Oceanic Eddy Fields," Deep Sea Research, 23 (August 1976), 783-794.

The geographic variations in the oceanic baroclinic eddy field intensity, as indicated by the structure function of the dynamic height across the thermocline after seasonal and large scale trends are removed, is examined using historical data from the North Atlantic and North Pacific oceans. An inverse relationship between eddy field intensity and distance from the western boundary current is found in each region, confirming that the western boundary currents are major energy sources for baroclinic eddies in mid-ocean regions. Eddy energy is largely confined to the northern and western areas of the North Atlantic and North Pacific sub-tropical gyres, with significantly reduced energy levels both in the eastern areas and north of the Sub-Arctic Frontal Region. Dominant eddy field length scales of energy variability consistent in magnitude with those of more recently observed eddies also are confirmed for the North Pacific. Spatial statistics similarly computed from selected Mid-Ocean Dynamics Experiment (MODE-I) hydrographic data are consistent with those determined from the historical data. The statistical characteristics of the structure function are evaluated empirically to estimate the confidence levels of the historical data statistics.

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EDSALL, Douglas W., Associate Professor, "Trace Elements in Tephra as Indicators of Magmatic Composition in the Aleutians," Geological Society of America Bulletin, 87 (September 1976), 1269-1272.

The Sr, Rb, Ti, and Zr concentrations of 16 volcanic ash samples from Leg 19 of the Deep Sea Drilling Project were determined by x-ray fluorescence. The age of each ash sample had been established previously by faunal criteria and had been confirmed by fission-track dating. Variations in the trace-element concentrations through the past 8 m.y. are clearly seen. Seven of the ashes are older than 4 m.y., have low  $TiO_2$  contents, and have Sr concentrations of less than 200 ppm; they are thus similar to tholeiitic basalts of island arcs. Nine ashes are younger than 4 m.y. and are similar in trace-element content to andesite. Magmatic evolution of the Aleutian arc over the past 8 m.y. is clearly shown.

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HOFFMAN, John F., Professor, "Environmental Pollution," Chapter 15 in Knight's Modern Seamanship, 16th edition, New York: Van Nostrand-Reinhold, 1977.

This chapter, an addition to previous editions, covers the field of environmental pollution from the hydrologic cycle and ecology to the problems of pollution. Discussed are oil pollution, heavy metal pollution, thermal pollution, radiological pollution, pesticides, offshore dumping, solid waste disposal, air pollution and noise pollution. Also discussed are legal controls. Particular emphasis is placed on the impact of the pollution on the oceanic environment.

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WILLIAMS, Jerome, Professor, Editor, "Tools and Methods," in Estuarine Processes, II, New York: Academic Press, 1977, p. 1.

An attempt has been made to present a few examples of tools and methods representative of the large strides made in this general area within the last few years. Kjelson and Colby, for example, suggest the use of a specially designed net for use in estimating fish populations. Even when the well known otter trawl is used, there is still some doubt as to the reproducibility of the data obtained. McKay describes the new hydraulic model of Chesapeake Bay, showing the many differing studies that may be performed, but also indicating a few that even this newest model facility cannot handle.

Klemas is perhaps the most optimistic of the authors in this group, spelling out the myriad of measurements that can be made by remote sensing. New ideas continue to be developed as new portions of the electromagnetic spectrum become available. But even he sounds a pessimistic note when he indicates the continuing need for "ground truth." It appears there will always be a need for fixed surface instrumentation in conjunction with remote sensing.

In summary, this group of papers raises more questions than it answers. It has always been so and probably always will be.

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PRESENTATIONS

OCEANOGRAPHY DEPARTMENT

DANTZLER, H. Lee, Jr., Lieutenant Commander, USN, "On Mapping the Vertical Variability in the Thermocline Using Expendable Bathy-thermograph Probes." Paper read at the Naval Oceanographic Research and Development Activity, NSTL Station, Massachusetts, 26 April 1977.

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DANTZLER, H. Lee, Jr., Lieutenant Commander, USN, "Status of the Determination of Mesascale Thermocline Variability in the North Atlantic." Paper read to UNESCO-SCOR WG 34, Harvard University, Cambridge, Massachusetts, 5 February 1977.

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EDSALL, Douglas W., Associate Professor, "Sediment Waves in the South China Sea." Paper read at American Geophysical Union, San Francisco, California, 7 December 1976.

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## PHYSICS DEPARTMENT

Professor Ralph A. Goodwin, Chairman

The research program in the Physics Department continues to develop along several fronts. Present activity includes a cosmic ray group, a solid state group, and individual researchers in the electrical properties of materials, acoustic cavitation, flow generated cavity resonance, stellar photometry, and theoretical problems. In each instance, midshipmen are, or have been, actively engaged in the research, either as Trident Scholars or through accredited research project courses.

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## NUCLEATION AND CAVITATION INCEPTION IN WATER

Researcher: Associate Professor Lawrence A. Crum

Sponsor: Naval Academy Energy Environmental Study Group (Code NAVSEA 0331)

The technical objective of this project was to examine the conditions required for microbubbles to be nucleated from solid particulate matter and the effect of the nucleation upon acoustic cavitation inception.

This problem was examined by measuring the effect of liquid surfactants upon the acoustic cavitation threshold, and then using these data to obtain certain requirements on the mechanism for microbubble production. In particular, it was found that if the acoustic cavitation threshold was always greater than five atmospheres, then the crevices in solid particulate matter that gave rise to the microbubbles must have apex angles less than 10 degrees and mouth radii less than 1.0 microns.

Further, it was possible to predict correctly the observed variation of the cavitation threshold with surface tension in water doped with surfactant, and to explain qualitatively many details of the nucleation and cavitation inception process.

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## ULTRASONIC VELOCITY AND ABSORPTION MEASUREMENTS IN LIQUID MONOPROPELLANTS

Researcher: Associate Professor Lawrence A. Crum

Sponsor: Naval Ordnance Station

The objective of this project was to determine the degree of structural ordering of nitrate salts in an aqueous solution.

Ultrasonic velocity and absorption measurements were made of aqueous solutions of some nitrate salts in order to determine if structural association was occurring. Because no relation was observed in the frequency range studied, (5-90 MHz), it was concluded that structural effects were minimal.

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## MECHANISM OF FLOW-EXCITED CAVITY RESONANCE (PHASE 2)

Researcher: Professor Samuel A. Elder

Sponsor: General Hydromechanics Research Program  
Naval Ship Systems Command, administered by  
David W. Taylor Naval Ship Research and Development Center

The overall objective is to develop a physical model of the mechanism of flow-excited cavity resonance by means of which the effect can be controlled or eliminated in the design of ships and aircraft. The experimental method utilized is a computerized synchronous hot-wire technique, developed during an earlier phase of the project, by means of which the three-dimensional dynamic response of a separated shear layer has been mapped out.

In principle, the cavity resonator system represents a feedback amplifier with predictable characteristics. The present research is contributing toward an understanding of two areas needed to complete the model: (1) the growth pattern of large-amplitude turbulent shear layer oscillations, and (2) the mechanism of momentum exchange between shear layer and acoustic cavity mode. Progress has been made in both areas during the past year. Interface wave profiles, reconstructed by computer data reduction methods, have been found to follow a pattern which can be approximately represented by elementary wave forms. A simple relationship has been discovered between the phase of the interface oscillation and the cavity standing wave field, which points to a momentum coupling mechanism similar to that found in some organ pipe oscillators.

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## GALACTIC STRUCTURE STUDIES

Researcher: Assistant Professor William E. Fasnacht

Sponsor: Naval Academy Research Council

This is a study of large scale galactic structure, particularly spiral arm configurations. Working with cylindrically symmetric solutions of Poisson's equations for the gravitational field, the researcher has obtained purely theoretical results indicating that a number of simple solutions correspond to stable rotation curves. Individually, these rotation curves corresponding to simple solutions do not agree with known or presumed galactic rotation curves; so, the study is currently concerned with the representation of such given curves by a finite series of simple solutions. Concentrating upon the Andromeda (M 31) galaxy, the researcher has found that the apparently simple procedure of least squares fit the data contaminated by data that demand negative mass in one region and by an obvious contribution from a galactic nucleus that must apparently be treated separately.

When these issues are settled or ignored, the study will shift to the question of the stability of the resulting mass and velocity distributions. The process will be repeated for our own galaxy, for which the rotation curve is much less certain. Finally, for these and some other models we will look at the existence and stability of simple spiral arms.

One continuing objective, which appears increasingly unlikely to be reached, is a simple density wave differential equation for the galactic medium. Should this be found, the character of the spiral arm problem changes completely. Failing to find adequate approximations to produce a wave equation, the researcher has concluded that the first objective in such a search is what we are doing now--establishing adequate models of the mass and velocity distribution in galaxies where spiral arms are known to exist.

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#### DIPOLAR RELAXATION IN SOLID DIELECTRICS

Researcher: Assistant Professor John J. Fontanella

Sponsor: Naval Academy Research Council

The objective of the project is to measure the real and imaginary parts of the dielectric constant at five audio frequencies at zero pressure over the temperature range 5.5-400K and at pressures up to 3000 atmospheres for a variety of solids.

The primary focus of the experiment is the alkaline earth fluorides doped with rare earths. The basic problem associated with these materials is to determine the impurity configurations. Dielectric measurements provide useful information mainly when dipolar complexes are present with relaxations times on the order of milliseconds. In this case, a peak is found in the imaginary part of the dielectric constant when the relaxation time equals the reciprocal of the applied frequency. Most of the results are described in the Research Course Project abstracts and by Midshipman Donald Link, who was sponsored under the Trident Scholar program.

Other work performed includes the completion of measurements of Li, Na, and K doped calcium fluoride. The work on alkali metals in alkaline earth fluorides is being carried out in collaboration with Dr. A.V. Chadwick of the University of Kent at Canterbury, England. Extensive data has also been obtained on both the pressure and temperature variation of the dielectric properties of the anisotropic crystals quartz, sapphire, calcite, and magnesium fluoride. Further work is necessary on the latter two materials since more questions than answers have been generated by that work. In addition, work on diamond has been completed.

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DIELECTRIC STUDIES OF Si AND Si WITH SiO<sub>2</sub> SURFACES

Researchers: Associate Professor Richard L. Johnston and Assistant Professor John J. Fontanella

Sponsor: Naval Research Laboratory

The dielectric constant of samples of Si and Si with SiO<sub>2</sub> surfaces was measured at atmospheric pressure at -5 audio frequencies as a function of temperature from 5.5K to 293K.

Below 18K the dielectric constant was nearly constant with respect to both frequency and temperature. The values of the dielectric constant (conductivity/resistivity) were different and might be a way of measuring the defect concentrations and of characterizing these materials.

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MEASURING DAMPING CONSTANT ASSOCIATED WITH OSCILLATING BUBBLES

Researcher: Associate Professor David A. Nordling

Sponsor: Naval Academy Research Council

The purpose of this project is to experimentally measure the damping of oscillating bubbles in an acoustic field and compare the results with existing theory. The plan of investigation is to compare the phase relation associated with light scattered from the oscillating bubble and that of the acoustic driving signal yielding experimentally the damping constant.

The necessary apparatus has been assembled and preliminary results have been obtained. It is planned to continue further with this work in the coming year.

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THERMAL NEUTRON SCATTERING AMPLITUDES

Researcher: Associate Professor Carl S. Schneider

Sponsor: National Science Foundation

The objectives were to determine precisely the thermal neutron scattering amplitudes of oxygen and germanium and then to observe the small angle scattering of thermal neutrons from amorphous TbFe<sub>2</sub> to investigate the extended short range magnetic order in the sample.



## SPONSORED RESEARCH

## PHYSICS DEPARTMENT

The method used is to scan the prism refracted or sample scattered beams with the analyzer crystal of a double perfect crystal spectrometer.

Progress this year was in developing adjustably mosaic crystals of Si and Ge to enhance the neutron fluxes scattered and detected. Thermal gradient distortion of crystal lattice spacings produced negligible mosaic due to small expansion coefficients and large thermal conductivities of the samples. A static transverse strain device ("crystal bender") was developed which reversibly enhanced the mosaics by a factor of eight. The increases were compared with both kinematic and dynamical diffraction theoretical predictions and agreed with Kuriyama and Miyakawa: intensity from strained perfect crystals never reaches the kinematically predicted limit. This strain device does suffer from a defocussing when wide beam collimation is used. A Piezoelectrically driven composite half-wave oscillator is being fabricated to exploit the mosaic from the strain field of crystal in resonant vibration.

The theory of Christiansen filter determination of thermal neutron scattering amplitudes with the double perfect crystal spectrometer was also developed.

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#### TRAP CHARACTERIZATION IN SEMICONDUCTORS USING DEEP LEVEL TRANSIENT SPECTROSCOPY (DLTS)

Researcher: Associate Professor Robert N. Shelby

Sponsor: Naval Research Laboratory

The objective of this project is to establish and develop the capability for the identification and study of a class of impurity, fabrication, and radiation induced traps in semiconductors at the Naval Research Laboratory. The technique to be used, DLTS, is a capacitance transient thermal scanning method which is spectroscopic and has the sensitivity and speed to allow for detailed study or surveys of the traps in the region of p-n or Schottky barrier junctions. The technique will be used to investigate traps with a wide range of depths, including radiative and non-radiative centers, in materials and devices of interest and current importance to NRL research and development.

A DLTS system was assembled using a 1 MHz commercial capacitance bridge to sense capacitance transients. The bridge was modified to enable the analog output to follow the capacitance transients and a technique to decouple the bias pulse from the bridge circuit was developed. The system response was checked using electron irradiated Si p-n junctions with known traps and data gathering techniques were

established. Finally, the p-n junction characteristics necessary for successful trap studies were established. Conversations with J. Comas in the Electronics Technology Division established that ion implanted GaAs samples would be a fruitful area of investigation, and his group fabricated a set of samples that are currently being studied. Measurements on a GaAs MOS capacitor sample furnished by J. Standard of Semiconductors established the ability of the system to detect traps in samples of this type.

Current work includes measurements with the 1 MHz bridge and development of a higher frequency (15-20 MHz) system which will allow measurements over a larger range of trap parameters.

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#### CONTACTLESS CONDUCTIVITY OF VITREOUS SEMICONDUCTORS

Researcher: Associate Professor Donald J. Treacy

Sponsor: Naval Academy Research Council

The object of this set of experiments was to measure the conductivity of some vitreous semiconductors in the megahertz and visible frequency ranges. This type of measurement should allow interpretation of the conductivity which is independent of the effects of contact material and thus provide a test of structural models.

The measurements were performed on an adaptation of an AC Q-meter reported in the literature. In this apparatus the sample is dropped through the coil of a marginally stable oscillator and the power loss of the oscillator measured. The power loss is proportional to the conductivity of the sample. Measurements of vitreous  $\text{Ti}_2\text{SeAs}_2\text{Te}_3$  have determined this system to be inhomogeneous in composition. This is possibly the only type of conductivity measurement which could reach such a conclusion, for it samples the semiconductor piece by piece as it falls through the coil of the marginally stable oscillator. Further, this measurement is independent of any blocking effects which may be caused by point probes.

No structural models have been proposed, for it is difficult to characterize an inhomogeneous system. This set of measurements, however, does offer a reasonable explanation for the inconsistency of the reported properties of vitreous  $\text{Ti}_2\text{SeAs}_2\text{Te}_3$ .

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## DIELECTRIC RELAXATION IN RARE-EARTH DOPED CALCIUM FLUORIDE CRYSTALS

Researcher: Midshipman 1/C Donald Link

Adviser: Assistant Professor John J. Fontanella

Sponsor: Trident Scholar Program

The complex dielectric constant was measured at five audio frequencies ( $10^2$ - $10^4$  Hz) over a temperature range of 5.5-400K for calcium fluoride crystals doped with 13 different rare-earths of the lanthanide series. The results allow an unambiguous labeling of the spectrum for the first time. Five relaxations were observed which are characteristic of the series and five major new trends were observed in these relaxations. Evidence was also uncovered indicating the possibility of a sixth relaxation occurring at high temperatures.

Work was also done on computer models of a dipolar complex in this crystal which led to the proposal of a new model to account for one of the relaxations. Models were also proposed for the other relaxations observed.

By characterizing the dielectric spectrum for all rare-earth dopants, this project has laid the groundwork for a future study on the effects of neutron irradiation of the crystals. It is hoped that this will lead to the development of an improved neutron dosimeter.

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## COMPUTERIZED HOT-WIRE INVESTIGATION OF SEPARATED-SHEAR LAYERS WITH APPLICATION TO SHIP SILENCING

Researcher: Midshipman 1/C David M. Schubert

Adviser: Professor Samuel A. Elder

Sponsor: Trident Scholar Program

A study has been completed of the stability of a two-dimensional air jet. The initially laminar flow was excited using sound from a loudspeaker. The flow was found to turn turbulent at a downstream distance of approximately five times the jet's width, in agreement with earlier studies of Sato. Use was made of a new computerized hot-wire technique for studying the jet's disturbances. Random fluctuations of the jet were removed by computer averaging, leaving only the periodic component of the jet's disturbance. Measurements of the wavelength, phase velocity, and amplification factor of the disturbances made using

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this technique were compared to available theoretical values. Comparison of the results to space and time dependent instability theories show that the disturbances of the jet amplify in space rather than in time, in agreement with the predictions of Michalke. Some slight non-linear effects were noted even though the magnitude of the excitation was only 0.33% of the jet's speed. This agrees with recent studies by Moore who predicts non-linear effects at excitation levels as small as 0.02%. The work is directly related to current, Navy-supported investigations of flow-excited cavity resonance. It has important applications to ship silencing and sonar self-noise.

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## VARIATION OF RECTIFIED DIFFUSION GROWTH RATES WITH SURFACE TENSION

Researcher: Associate Professor Lawrence A. Crum

The technical objective was to determine the effect of surface active agents on rectified diffusion thresholds and growth rates.

Measurements of the threshold for the rectified diffusion of air into a pulsating bubble in a liquid have agreed with theory. However, measurements of the growth rates seem to be several orders of magnitude different from the theoretical predictions. This project is examining the possible added rectification due to surface active agents.

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HELM MODEL FITS TO THE GIANT RESONANCE STATES OF  $C^{12}$ 

Researcher: Assistant Professor John P. Ertel

Ten more energy levels have been studied and fitted since the last report.

The increased success rate in fitting these levels is due to a new and more efficient fitting program developed by the author which makes use of the "method of steepest approach" coupled with a new "boxing" or "seeding" technique.

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## MODEL FOR REFRACTIVE INDEX GROWTH IN THE LENS OF THE EYE

Researcher: Lieutenant Robert L. Siddon, USNR

It has been known for some time now that the refractive index of the lens of the eye is not uniform but, in fact, increases gradually from a minimum of 1.386 at the periphery to a maximum of 1.406 in the central region. It is known that such a refractive gradient increases the refractive power of the lens. This research shows that in addition to the increased refractive power, the refractive gradient serves to remove the spherical aberration of the eye's refractive system.

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## ELECTRON PARAMAGNETIC RESONANCE AND DIELECTRIC STUDIES OF VACUUM ANNEALED ERBIUM DOPED CALCIUM FLUORIDE

Researcher: Midshipman 1/C David Bair

Advisers: Assistant Professor John J. Fontanella and Professor Charles W. Rector

The purpose of the project was to determine site symmetries for various impurity complexes in rare earth doped calcium fluoride. Toward this end, both dielectric and electron paramagnetic data was taken for samples of 0.3 mol-% erbium in calcium fluoride both before and after a two hour vacuum anneal at 1120 K followed by a quick quench.

The dielectric results were quite interesting, showing two relaxations which grew by a factor of three, one which grew by a factor of 10, and one which decreased by a factor of three. These results are important steps forward in an attempt to understand the origin of the relaxations.

Analysis of the Electron paramagnetic data was begun. Most of the semester was spent developing techniques for interfacing the experiment with the Textronix computer terminals. While most of the data remains unanalyzed, sufficient information was extracted to show that the relaxation which grew by a factor of 10 is probably somehow associated with a cubic rare-earth. It is also obvious that the data contains much more information concerning symmetries of the various relaxations.

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## SAMPLE PREPARATION AND DIELECTRIC STUDIES OF Ce, Eu, AND Gd DOPED STRONTIUM FLUORIDE

Researcher: Midshipman 1/C Lawrence Clifford

Adviser: Assistant Professor John J. Fontanella

The purpose of the project was to study several different rare-earths in strontium fluoride. Samples of 0.1, and 1.0 mol-% cerium, europium, and gadolinium doped strontium fluoride have been ground on a planetary lapping machine and polished using diamond paste on pella paper. Aluminum electrodes have been evaporated onto the faces of the samples in a three-terminal configuration. Measurement of the capacitance and conductance divided by the frequency over the temperature range 5.5-400K has begun.

The initial high temperature data is quite interesting. It appears that the activation energy decreases rather than increases with increasing radius of the rare earth ion. This is opposite to the general trends observed in calcium fluoride. This work on strontium fluoride will complement the recent work by Trident Scholar Donald Link on calcium fluoride. In addition, it will be of interest since Midshipman Jones has found that the relaxations in erbium doped strontium fluoride are not Debye-like. The question to be answered is whether this trend is rare-earth dependent.

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## SOLAR ENERGY

Researcher: Midshipman 2/C Mike Duncan

Adviser: Associate Professor Billie J. Graham

A study was made of the components of a solar energy system, including measurements by a pyranometer, a pyroheliometer, and a digital thermometer. A flat-plate solar collector and a test stand for the collector were designed and constructed. Measurements on insolation, flow rates and temperature were made on this collector. The stagnation temperatures within an evacuated tube collector were also measured.

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## DEVELOPMENT OF APL PROGRAMS USEFUL FOR EXPERIMENTAL DATA REDUCTION

Researcher: Midshipman 1/C Warren Estes

Adviser: Professor Charles Rector

The main thrust of the project initially was to use the powerful APL computer language to develop a generalized least squares program to fit experimental data to an arbitrary function. This involved, besides learning to use APL, acquiring familiarity with efficient numerical methods. After these preliminaries, some progress had been made on the LSQFIT program when it was learned that Mr. Robert Dunbar of the Academic Computer Center was working on an implementation of the .IV APL operator. Since this directly affected the LSQFIT program, further work was deferred until that implementation was complete and effort was directed toward obtaining roots of polynomials. This led to methods of handling complex numbers. APL operators were developed which added and multiplied complex numbers, evaluated complex polynomials, performed synthetic division, multiplied complex polynomials, and obtained complex roots of polynomials. These useful operators have been incorporated in the APL sublibrary.

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LOW FREQUENCY PULSATION OF AIR BUBBLES

Researchers: Midshipmen 1/C James D. Felton and Stephen J. Nolan

Adviser: Associate Professor Lawrence A. Crum

The technical objective of this project is to obtain photographs of the jet-type collapse of pulsating air bubbles under reduced pressure and oscillating near a boundary. Midshipmen Felton and Nolan plan to extend the work of Trident Scholar N. Karengelin, and to obtain detailed photographs of the collapsing jet.

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MICROWAVE HEATING OF TAPWATER

Researchers: Midshipman 1/C William D. Frost and Midshipman 2/C Fredrick Lucci

Advisers: Associate Professor Carl S. Schneider and Assistant Professor John P. Ertel, Jr.

The original objective was to determine the feasibility of using microwave power to heat water locally on board submarines to eliminate steam lines. If the goal were feasible, a working model would be prepared to determine its operating parameters.

A literature search of about four weeks, plus calculations of the power required for various water uses suggested that the approach was not advantageous. The remainder of the semester was spent developing alloying procedures, studying phase diagrams and calculating diffusion rates in the preparation of samples for a student magnetism experiment.

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ACTIVATION VOLUMES FOR DIPOLAR COMPLEXES IN RARE-EARTH DOPED ALKALINE EARTH FLUORIDES

Researcher: Midshipman 2/C L. Michael Hayden

Adviser: Assistant Professor John J. Fontanella

The purpose of the project was to make a first determination of the effects of pressure on relaxations in strontium and barium fluoride. Midshipman Hayden has completed measurement of the complex dielectric constant at pressures up to 3000 atm every 5K over the temperature range 260-360K for erbium doped strontium and barium fluoride. Consequently, the principal relaxation in each material has been completely characterized.

The rather intricate data analysis has been begun. The analysis is only partially complete since this is the first time such work has been done. However, it is obvious that large changes are being observed. This should allow a first determination of activation volumes for these relaxation mechanisms. The results will be interesting in the light of work on calcium fluoride which has been performed but not yet analyzed.

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## THE ORBITAL RESONANCE OF NEPTUNE AND PLUTO

Researcher: Midshipman 2/C Steven Hopkins

Adviser: Professor Gerald P. Calame

The planetary motions of Neptune and Pluto exhibit a resonant behavior that keeps their orbits from intersecting, and that prevents the two planets from approaching the nearest points of their orbits at the same time. This observation has led many astronomers to argue against the theory that Pluto could have once been a moon of Neptune that somehow escaped, even though much other evidence supports that theory. The present researchers suggest that the argument from resonant orbits is fallacious in that once resonance is established in a system, all traces of the initial conditions are lost.

The purpose of the present project is to begin with the assumption that Pluto originally was a moon of Neptune that escaped, and to then find, firstly, the rapidity with which orbital resonances are established given the supposition that the escape takes place with initial conditions which are known to lead to resonance, and secondly, the range of initial conditions that will lead to establishment of a resonance. The study is being conducted numerically, using a program that integrates the two planetary motions forward in time. The equations of motion of the planets are integrated in a coordinate system centered on the sun that rotates with the planet Neptune--orbital resonances in such a coordinate system are easily discerned.

Work to date shows that if Pluto escapes with initial conditions for the establishment of a  $3/2$  resonance (this is the observed resonance between Pluto and Neptune), the resonance establishes itself very quickly indeed, much more rapidly than a  $4/3$  resonance, for example, will be established given the initial conditions for that resonance. This suggests that the  $3/2$  resonance may be very easy to establish over a wide range of initial conditions. Further work is in progress.

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## DIELECTRIC RELAXATION STUDIES OF ERBIUM DOPED ALKALINE EARTH FLUORIDES

Researcher: Midshipman 1/C David L. Jones

Adviser: Assistant Professor John J. Fontanella

Measurement of the vacuum complex dielectric constant for erbium doped strontium and barium fluoride in three concentrations 0.01, 0.1, and 1.0 mol-% over the temperature range 5.5-400K has been completed. Most of the time was spent on data analysis. The first result of the work is that an activation energy was obtained for both materials which is 0.1 ev larger than previous reports for the relaxations in either strontium or barium fluoride. A close analysis of the data showed that the reason for the discrepancy is that the peaks in these materials are not Debye-like. Consequently, any activation energy determined from the shape of a peak is erroneous. In fact, activation energies were determined using the shapes of the current peaks and agreement with previous work is found. The only correct way to get an activation energy, however, is by a shift in the position of a peak with frequency. In the present work, it gives a totally different value. Such is not the case in calcium fluoride where both techniques give similar results, i.e., the peaks are fairly Debye-like.

A second result is the discovery of a low temperature peak in strontium fluoride analogous to that observed in calcium fluoride. In strontium fluoride, however, the peak occurs at higher concentrations. No similar peak was observed in erbium doped barium fluoride.

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## DESIGN AND CONSTRUCTION OF AN INTEGRATED CIRCUIT FEEDBACK TEMPERATURE CONTROLLER

Researcher: Midshipman 2/C Thomas Lauzon

Adviser: Assistant Professor John J. Fontanella

Recent experiments on the pressure dependence of dielectric relaxation phenomena in solids have shown that it would be highly desirable to extend the pressure capability to lower temperatures. Toward this end, Midshipman Lauzon had designed an integrated circuit feedback temperature controller which will work in the region around 200K. The circuit has been constructed and is operational. The controller will be used in conjunction with a heater in a circulating liquid temperature bath. Cooling will be done with either liquid nitrogen or dry ice. The new apparatus will allow pressure experiments on the principal relaxation in rare-earth doped calcium fluoride.

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## ANNEALING BEHAVIOR OF ALKALINE EARTH FLUORIDES DOPED WITH RARE EARTHS

Researcher: Midshipman 1/C Michael L. Scott

Adviser: Associate Professor Donald J. Treacy

The purpose of this investigation is to determine the defect structure of  $\text{CaF}_2 : \text{RE}^{3+}$ ,  $\text{SrF}_2 : \text{RE}$  and  $\text{BaF}_2 : \text{RE}^{3+}$  (where  $\text{RE}^{3+}$  stands for trivalent rare earth ions). The  $\text{RE}^{3+}$  ions used were Eu, Er, and Pr. The system most thoroughly studied was  $\text{Er}^{3+}$  in Ca, Sr and Ba fluorides.

Optical spectra of the various fluoride systems were taken on a Cary 17 recording spectrophotometer both before and after they had been annealed and quenched. The annealing and quenching process produced substantial changes in the defect structure of the materials as a function of rare earth dopant, concentration and species of alkaline earth ion.

The general conclusion of the study was that annealing and quenching destroys defect clusters in the lattice creating a more widely dispersed set of defects. There are, at the present, no models capable of explaining the results of this set of experiments. In correlation with dielectric loss measurements performed on this set of crystals, a new set of models for defect structures is being constructed.

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ANNEALING BEHAVIOR OF  $\text{CaF}_2 : \text{Er}^{3+}$ 

Researcher: Midshipman 1/C Michael L. Scott

Adviser: Associate Professor Donald J. Treacy

The purpose of the investigation was to determine the effect of annealing on  $\text{CaF}_2 : \text{Er}^{3+}$ . Samples having concentrations of  $\text{Er}^{3+}$  of 0.01%, 0.1%, 0.3% and 1.0% were investigated. The annealing was done in a vacuum at nominal pressures of  $10^{-6}$  torr in quartz tubing. The annealing temperature was circa 850 C. Two methods of cooling the samples were used: (1) allowing them to cool in the oven over a period of approximately 10 hours, and (2) withdrawing the quartz tube from the oven and cooling in vacuum in about 5 minutes. The latter method was found to induce an equilibrium characteristic of an elevated temperature. The results of the annealing and quenching were observed using a Cary 17 recording spectrophotometer. The anneal and quench procedure was found to reduce the absorption associated with clustered defects and enhance the spectrum attributed to defects with tetragonal symmetry. The results were correlated with dielectric loss measurements in an attempt to determine the defect configurations present in  $\text{CaF}_2 : \text{Er}^{3+}$ .

The work is still in progress. A set of experiments designed to identify the mobile ion is being performed.

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CRUM, Lawrence A., Associate Professor, "Acoustic Levitation, A Useful Experimental Technique," Journal of the Acoustical Society of America, S21(April 1976), 60.

The nonzero, time-averaged acoustic force exerted by a sound field on a local inhomogeneity allows liquid, solid, and gaseous particles to be suspended in a fluid medium relatively free of physical restraints. This splendid isolation allows studies to be made of radiation pressure, rectified diffusion, damping constants, acoustic streaming, surface waves, and physical parameters of metastable states, as well as many other phenomena, that would be nearly impossible without it. A review will be given of the general technique, and of various ways it can be utilized to obtain experimental data. (This research was supported by the Office of Naval Research.)

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CRUM, Lawrence A., Associate Professor, "Nucleation and Cavitation Inception in Water," USNA-EPRD Report C276, November 1976.

Studies were made of the threshold for acoustic cavitation inception in degassed water as a function of surface tension. The measurements were made at a frequency of 37.5 kHz and a surface-active agent was used to reduce the surface tension. It was discovered that a surfactant concentration of 25 ppm was sufficient to reduce the surface tension by 30% and increase the cavitation threshold by a factor of 3. Analysis of a model for heterogeneous nucleation indicated that the surfactant was increasing the threshold by advancing the air-water interface for gas trapped in crevices in solid particulate matter.

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CRUM, Lawrence A., Associate Professor, "Ultrasonic Absorption and Velocity Measurement in HAN," Naval Ordnance Station Internal Report, No. C-77, April 1977.

Ultrasonic absorption and velocity measurements were made as a function of frequency, concentration, and temperature for aqueous solutions of HAN. The frequency ranged from 5 - 70 megahertz, the temperature for 0 - 45°C, and the concentration from 0 to 80% HAN. It was found that no appreciable dispersion occurred in this frequency range for various concentrations and temperatures. Absorption measurements were hampered by lack of appropriate alignment of the crystals in the ultrasonic interferometer, but the absence of dispersion indicates a classical absorption range and thus no structural arrangements in the aqueous solution. A high-power, ultrasonic, propellant-sensitivity monitoring device was

also constructed that was successful in causing fizz-burning of the propellant in an operational test. It was discovered, however, that certain design restrictions hampered its active range and ignition attempts were successful only for elevated pressures. The device is functional, however, and with small modifications, it could be readily used to accomplish its designed purpose.

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ELDER, Samuel A., Professor, and Midshipman 1/C David M. SCHUBERT, "A Computerized Hot-Wire Investigation of the Stability of Separated Shear Layers with Application to Ship Silencing," Trident Scholar Project Report, Physics Department, U. S. Naval Academy, Annapolis, Maryland, May 1977.

A study was made of the stability of a two-dimensional air jet. The initially laminar flow was excited using sound from a loudspeaker. Due to instability of the free boundary layers, the initial disturbance caused by sound pressure was found to be amplified exponentially.

The laminar flow was found to turn turbulent at a downstream distance of approximately five jet widths, in agreement with earlier studies by Sato. At this distance, the amplification rate of the disturbance became less than exponential.

Use was made of a new computer-assisted hot-wire technique. The position of the jet profile was recorded at different times referenced to the phase of the sound wave. Random jet fluctuations were removed by computer averaging, leaving only the periodic component of the disturbance. Measurements of wavelength, phase velocity and amplification factor of the disturbances made using this technique are compared to available theoretical values.

Comparison of the results to space and time dependent instability models show that the disturbances of the jet amplify in space rather than in time, in agreement with the prediction of Michalke. Some slight non-linear effects were noted even though the magnitude of the excitation was only 0.33% of the jet's speed. This agrees with recent studies by Moore who predicts non-linear effects at excitation levels as small as 0.02%.

The results of this study are applicable to studies of flow-induced cavity resonance, which is a major cause of sonar self-noise and of vibrations in ships and aircraft.

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## PUBLICATIONS

## PHYSICS DEPARTMENT

FONTANELLA, John J., Assistant Professor, and Donald LINK, Midshipman 1/C, "Dipolar Relaxation in Rare Earth Doped  $\text{CaF}_2$ ," Bulletin of the American Physical Society, 22(March 1977), 351.

The complex dielectric constant has been measured at five audio frequencies over the temperature range 5.5-400 K for thirteen different rare earths in calcium fluoride. Nominal concentrations of 0.1 and 1.0 mol-% have been studied. Particular attention is paid to the 0.03 eV cluster--associated relaxation and the 0.15 eV relaxation of unknown origin. In addition, the results for the 0.4 and 0.7 eV relaxations, which are usually associated with nearest neighbor and next nearest neighbor interstitial fluorine--rare earth dipoles, are described. Evidence against the latter assignment is presented.

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FONTANELLA, John J., Assistant Professor, co-author, "Dielectric Studies of  $^{60}\text{Co}$ -Irradiated and Oxygen-Annealed Rare-Earth Doped Calcium Fluoride," Journal of Physics, Colloquium C7, supplement. 37(December 1976), C7-273--C7-278.

Crystals of pure and europium and erbium doped calcium fluoride have been annealed in dry oxygen. In addition, several samples have been irradiated with radiation from a  $^{60}\text{Co}$  source. The complex dielectric constant for these crystals has been determined over the temperature range 5.5-400 K at the five audio frequencies  $10^2$ ,  $10^{2.5}$ ,  $10^3$ ,  $10^{3.5}$ , and  $10^4$  Hz. Oxygen annealing is found to have a marked effect on the dielectric spectrum of each crystal. The results are used to discuss possible origins of the observed relaxations. In addition, this treatment introduces a thermally activated conduction mechanism into the crystals with an activation energy of 0.78-0.87 eV. Several radiation induced relaxations were observed at low temperatures in the samples. Activation energies are determined for each relaxation. (Work was supported by the Naval Academy Research Council.)

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FONTANELLA, John J., Assistant Professor, Donald J. TREACY, Associate Professor, and David JONES, Midshipman 1/C, "Effect of Oxygen and Vacuum Anneal on the Dielectric Spectrum of Erbium Doped Alkaline Earth Fluorides," Bulletin of the American Physical Society, 22(March 1977), 351.

The dielectric spectra for erbium doped alkaline earth fluorides are presented. The first result of interest is that the low temperature relaxation which appears at a concentration of about 0.03% in  $\text{CaF}_2$ , is not found in 0.1% samples of  $\text{SrF}_2$ , but is observed in a 1% sample. An analogous peak is not observed in  $\text{BaF}_2$  in samples up to 1.0%. Since this relaxation is cluster-associated, (possibly with the 2-2-2 cluster of Cheetham et.al.) it is concluded that aggregate formation becomes



more difficult as the size of the cation increases. The second feature of interest is that the principal relaxation in  $\text{SrF}_2$  and  $\text{BaF}_2$ , usually associated with a nnn interstitial fluorine-rare earth dipole, is not very Debye-like, the peak being both broadened and skewed. Consequently, the actual activation energy, as determined in the present experiment, is about 0.1 eV higher than those reported by other methods. Finally, the effects of oxygen and vacuum anneal on the dielectric spectra are described.

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FONTANELLA, John J., Assistant Professor, Donald J. TREACY, Associate Professor, and S. M. JENKINS, Midshipman 1/C, "Electrical and Optical Properties of Vitreous  $\text{As}_2\text{S}_2$  and  $\text{As}_2\text{Se}_2$ ," Bulletin of the American Physical Society, 22(March 1977), 335.

The complex dielectric constant has been measured at five audio frequencies over the temperature range 5.5-300K at 0 pressure and at pressures up to 3 Kbar over the temperature range 260-320 K for various samples of vitreous  $\text{As}_2\text{S}_2$  and  $\text{As}_2\text{Se}_2$ . In addition the pressure dependence of the refractive index at optical frequencies has been measured for vitreous  $\text{As}_2\text{S}_2$ . In both materials a broad maximum is found in the real part of the low frequency dielectric constant at low temperatures. There appear to be no corresponding anomalies in the conductivity. In addition, a Debye-type relaxation is observed in the sample of  $\text{As}_2\text{Se}_2$  studied. Optical absorption measurements have also been carried out on this material.

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FONTANELLA, John J., Assistant Professor, co-author, "The Dielectric Spectrum of Europium Doped  $\text{CaF}_2$ ," Journal of Physics and Chemistry of Solids, 38(1977), 237-241.

The complex dielectric constant has been measured at five audio frequencies ( $10^2$ - $10^4$ Hz) over the temperature range 4.2-400 K for samples of europium-doped (nominal concentrations of 0.55% and 1.26%)  $\text{CaF}_2$ . Three strong relaxations are observed which indicates rather large amounts of the  $\text{Eu}^{3+}$  ion. Three principal relaxations, which have activation energies of 0.413, 0.573 and 0.746 eV, are compared with previously observed dipolar complexes in rare-earth doped alkaline-earth fluorides. Of particular significance is the absence of strong, low-temperature relaxations which are often found in rare-earth doped alkaline-earth fluorides. Several weak relaxations are also observed. (Work supported by the Naval Academy Research Council.)

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SCHNEIDER, Carl S., Associate Professor, "Small Angle Scattering: Instrument and Applications," NBS Technical Note 939, (1976), 78-82.

The double crystal thermal neutron diffractometer has been studied for use with Christiansen filter (powder immersed in various liquids): the intensity scattered and detected by the diffractometer is plotted over the three regions of neutron phase shift across the powder particle and a precision of a few parts per thousand (better than European flight path instruments) is predicted.

Work on enhancing the mosaic of the double crystals is described, including assymetric Bonse Hart cutting, thermal gradients and anti-clastic straining. The first suffers from compensating reduction in received intensity, the second is ineffective in low expansion materials and the third has an inherent defocussing of beams of modest collimation. Piezoelectric longitudinally-driven crystals in a composite half-wave oscillator are being fabricated. The intensity reflected from the bent crystals above are measured as a function of strain and verify kinematic limits as well as dynamical limits of diffraction intensity.

The application of the diffractometer to amorphous  $TbFe_2$  and critical scattering in Fe is discussed.

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TREACY, Donald J., Associate Professor, John J. FONTANELLA, Assistant Professor, and Michael L. SCOTT, Midshipman 1/C, "The Effect of Oxygen and Vacuum Annealing on the Optical Spectra of Erbium and Praseodymium Doped Alkaline Earth Fluorides," Bulletin of the American Physical Society, 22(March 1977), 351.

Crystals of  $CaF_2:Er^{3+}$ ,  $SrF_2:Er^{3+}$  and  $CaF_2:Pr^{3+}$  have been annealed in vacuum and oxygen at 1120K. The concentrations studied range from 0.01 mole % to 1.0 mole %. The Er doped samples show substantial effects from vacuum annealing even for short annealing times (c. 2 hours). The most prominent feature is the growth of an absorption band peaking around 198nm. This is not attributed to an oxygen associated defect. Crystals of nominally pure  $CaF_2$  show a similar effect while this is not observed in Pr doped samples.

The oxygen annealed Er doped samples show substantial growth of new bands, and the absorption associated with the new bands exceeds the absorption present before annealing in a 0.3% sample. This work has been correlated with dielectric relaxation measurements and the spectra have been identified as trigonal complexes. It is suggested that oxygen annealing can break up clusters.

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SIDDON, Robert L., Lieutenant, USN, co-author, "Limitation on the Quantum-Mechanical Extension of Baierlein's Entropy Theorem," American Journal of Physics, 44(October 1976).

Baierlein obtained a remarkable result on the intuitive relation between interactions and order as expressed by the Gibbs entropy. He found that the Gibbs entropy of classical equilibrium statistical mechanics for a system of free particles at density  $\rho$  and absolute temperature  $T$ ,  $S(K, \rho, T)$ , is greater than that for the same system with arbitrary velocity-independent interactions added,  $S(K + V, \rho, T)$ :

$$S(K + V, \rho, T) \leq S(K, \rho, T).$$

It has been an open question what the correct quantum-mechanical version of this theorem is. It is known that this equation is not valid for quantum-mechanical system of identical particles, as counterexamples can readily be found. We shall, in passing, present one below. Even for the restricted case of Boltzmann statistics there has been no proof of a relation corresponding to Eq. (1); the purpose of this note is to present a counterexample to the conjecture that Eq. (1) holds for Boltzmann statistics. Thus the ordering effect of interactions recognized in classical statistical mechanics can be disrupted by purely quantum (as contrasted with statistical) effects.

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WEHE, David K., Lieutenant (j.g.), USNR, "Turkey Point 4 Power Plant Workbook for Development of Improved Techniques for Gathering, Review, and Analysis of Information on Outages and Other Forms of Lost Generation in Large Coal-Fired and Nuclear Power Plants," Technical Report for Federal Energy Administration, February 1977.

The rising capital costs associated with new plant construction, coupled with increasing difficulties and delays in licensing and permitting, make it imperative that utilities obtain increased productivity from existing units, especially base-loaded units. In addition, increasing uncertainties in the international oil market add emphasis to the need to improve productivity at existing coal-fired and nuclear units.

Minimizing unintentional periods of low or lost production is one of the more cost-effective, readily achieved, means for improving productivity. In turn, the investigation of the basic causes of undesirable outages and periods of reduced plant operation is a fundamental element in any sound program for improvement in power plant productivity.

This 260-page publication illustrates a systematic, disciplined approach which, when followed, will enable a power plant investigator to conduct a thorough and comprehensive investigation into the causes of lost productivity at this plant or unit and to develop corrective actions to eliminate the causes of low productivity.

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PRESENTATIONS

PHYSICS DEPARTMENT

CRUM, Lawrence A., Associate Professor, "Acoustic Levitation, a Useful Experimental Technique." Paper read at the 92nd meeting of the Acoustical Society of America, San Diego, California, November 1976.

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ELDER, Samuel A., Professor, "Interface Wave Model for Deep Cavity Resonator Oscillation." Paper read at 92nd meeting of the Acoustical Society of America, San Diego, California, November 1976.

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ELDER, Samuel A., Professor, co-author, "Investigation of Scaling Law Models for a Rank of Stopped Diapason Pipes." Paper read at the 92nd meeting of the Acoustical Society of America, San Diego, California, November 1976.

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ELDER, Samuel A., Professor, "Error Analysis of CASH Method: Computer-Averaging of Noisy Periodic Signals." Paper read at the 93rd meeting of the Acoustical Society of America, State College, Pennsylvania, June 1977.

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FONTANELLA, John J., Assistant Professor, and Donald LINK, Midshipman 1/C, "Dielectric Relaxation in Rare-Earth Doped Calcium Fluoride." Paper read at the Society of Physics Student Program, 1977 Spring American Physical Society Meeting, Washington, D. C., 25-28 April 1977.

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FONTANELLA, John J., Assistant Professor, and David BAIR, Midshipman 1/C, "Dielectric Studies of  $^{60}\text{Co}$ -Irradiated and Oxygen-Annealed Rare-Earth Doped Calcium Fluoride." Paper read at the Second Europhysical Topical Conference on Lattice Defects in Ionic Crystals, West Berlin, Germany, 30 August-3 September 1976.

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FONTANELLA, John J., Assistant Professor, and Donald LINK, Midshipman 1/C, "Dipolar Relaxation in Rare Earth Doped  $\text{CaF}_2$ ." Paper read at the March meeting of the American Physical Society, San Diego, California, 21-24 March 1977.

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## PRESENTATIONS

## PHYSICS DEPARTMENT

FONTANELLA, John J., Assistant Professor, Donald J. TREACY, Associate Professor, and David JONES, Midshipman 1/C, "Effect of Oxygen and Vacuum Anneal on the Dielectric Spectrum of Erbium Doped Alkaline Earth Fluorides." Paper read at the March meeting of the American Physical Society, San Diego, California, 21-24 March 1977.

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FONTANELLA, John J., Assistant Professor, Donald J. TREACY, Associate Professor, and Michael SCOTT, Midshipman 1/C, "Electrical and Optical Properties of Vitreous  $\text{As}_2\text{S}_3$  and  $\text{As}_2\text{Se}_3$ ." Paper read at the March meeting of the American Physical Society, San Diego, California, 21-24 March 1977.

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FONTANELLA, John J., Assistant Professor, "Pressure Dependence on Dielectric Relaxation Phenomena in Solids." Paper read at the Topical Review of High Pressure Technology, Rensselaerville, New York, 7-9 June 1977.

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FONTANELLA, John J., Assistant Professor, and Richard L. JOHNSTON, Associate Professor, "Temperature and Pressure Variation of the Refractive Index of Diamond." Paper read at the Topical Meeting on Optical Phenomena in Infrared Materials, Annapolis, Maryland, 1-3 December 1976.

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GUTSCHE, Graham D., Professor, "Astrophysics: An Integrative Course." Paper read at New York Section, American Physical Society/A.A. P.T., Colgate University, 15-16 April 1977.

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HELBIG, Raymond A., Lieutenant Commander, USN, "Submarine and Surface Ship Self-Noise Measurement and Control." Guest speaker at the David W. Taylor Naval Ship Research and Development Center, Annapolis Laboratory.

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JOHNSTON, Richard L., Associate Professor, John J. FONTANELLA, Assistant Professor, et. als., "Temperature and Pressure Variation of the Refractive Index of Diamond." Paper read by Assistant Professor Fontanella at the Optical Society of America meeting on Optical Phenomena in Infrared Materials, Annapolis, Maryland, 1-3 December 1976.

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PRESENTATIONS

PHYSICS DEPARTMENT

TREACY, Donald J., Associate Professor, John J. FONTANELLA, Assistant Professor, and Michael SCOTT, Midshipman 1/C, "The Effect of Oxygen and Vacuum Annealing on the Optical Spectra of Erbium and Praseodymium Doped Alkaline Earth Fluorides." Paper read at the March meeting of the American Physical Society, San Diego, California, 21-24 March 1977.

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DIVISION OF  
PROFESSIONAL DEVELOPMENT

## LEADERSHIP AND LAW DEPARTMENT

Commander Peter D. Abbott, USN, Chairman

The Leadership and Law Department is responsible for teaching three leadership courses and one law course which are required of all midshipmen regardless of academic major. The faculty consists of twenty-one officers and two civilians with varied backgrounds in law and behavioral science related areas. Assistant Professor Harrison obtained a Naval Academy Research Grant and spent the intersessional period at the Naval Personnel Research and Development Center in San Diego. This work deals with data sampling techniques in social interaction situations. Professor Mann has conducted a brief study in the relationship between the GRE scores and the SAT scores.

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## SAMPLING SEQUENTIALLY ORDERED CATEGORICAL DATA IN OBSERVATIONAL STUDIES OF SOCIAL INTERACTION

Researcher: Assistant Professor Patrick R. Harrison

Sponsor: Naval Academy Research Council

Typically the data constructed in observational research consists of a set or mutually exclusive sets of unordered categorical variables. In order to obtain a sequential analysis of such data the descriptors must be ordered with respect to time.

Modified frequency sampling has been widely used in ethological and polythetic studies of the sequential or relational character of sets of behavioral descriptors. The general assumption in using modified frequency is that the relationship between events in terms of joint incident rather than simple frequency of occurrence is important. The fact that modified frequency bears only an approximate relation to duration and frequency has been suggested as a major weakness in its use. It has been suggested, in fact, that it is of little use as an approximate device for the measurement of actual frequency and duration and can introduce considerable distortion to analysis.

This research is aimed at investigating theoretically and empirically the relationship between modified frequency data and raw frequency and duration. It is the researcher's contention that the two systems bear a predictable relationship and that the failure to distinguish behavioral incident from behavioral state has been at the root of the lack of predictability.

Continuous pen recordings of behavior will be reanalyzed with respect to various counting techniques including modified frequency, event and state sampling, and raw frequency and duration. These will then be subjected to comparative analysis using correlational and regression techniques. Secondly, the actual data will be used to generate the observed distributions and develop the parameters of the expected distributions for each sampling technique. This is aimed at developing a statistical test of the probable goodness of fit between the derived approximation of raw frequency and duration and the expected in terms of parameters such as interval overlap, interval size, and length of modified data strings.

Observing behavior by analyzing continuous Esterline Angus pen-recordings allowed investigation of the relations between various counting techniques in a perfectly reliable system.

The empirical results suggested that both state sampling and modified frequency were predictive of absolute duration of behavior though considerably more variance was produced using state sampling.

SPONSORED RESEARCHLEADERSHIP AND LAW DEPARTMENT

These results remained fairly stable over observation intervals from 2 to 30 seconds for state sampling but showed increasing error with modified frequency. Modified frequency was also predictive of absolute frequency. State sampling was not predictive of absolute frequency and showed increasing insensitivity as the observation interval increased.

The theoretical side of the question is currently under investigation using linear models which include the following parameters: the total observation period, the length of the observation interval, the modified frequency or state values, and the length of consecutive strings of data. A paper addressing both the empirical and theoretical side of this project is in preparation.

This project has also spawned two additional projects. The first concerns the general problem of sequential analysis of behavioral data, and the second has to do with developing an adequate sequential model for the analysis of adult developmental data. The current focus of this second part is on a combination of career and adult development data.

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## THE RELATIONSHIP BETWEEN GRE SCORES AND SAT SCORES

Researcher: Professor Gregory J. Mann

It is widely known that midshipmen have greater strength in the engineering and science subjects than they exhibit in the social science areas. A correlation of the two sets of scores revealed a consistently high and meaningful correlation between the GRE Quantitative and SAT Math scores, and also between the GRE Verbal and SAT Verbal. Over 50% of the midshipmen had GRE Verbal scores significantly lower than their SAT Verbal scores, while only 13% had GRE Quantitative scores below their SAT Math scores. Less than 2% raised their GRE Verbal 50 points over their SAT Verbal, but 24% raised their GRE Quantitative scores more than 50 points over their SAT Math scores.

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## NAVIGATION DEPARTMENT

Commander William M. Ross, USN

The Navigation Department's research effort in 1977 was directed towards the development and implementation of computer and hand-held calculator formulas and techniques. Both midshipmen and Navigation instructors have contributed in this research effort. The results have been impressive. One project, "The solution of and algorithms for a celestial fix by computer using a non-altitude intercept method" is currently being investigated by staff members of the Naval Observatory. In addition, the Department has been active in research and development concerning computer-aided instruction. In recognition of our growing expertise in this field, a member of the Navigation faculty addressed the national Navigation Education Symposium, held in Kings Point, New York in April 1977, on the topic of Computer-Based Education.

The Navigation Department also produced six audio-visual cassettes and provided editing assistance for several navigation publications including The American Practical Navigator (Bowditch) and Navigation and Piloting (Dutton).

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RESEARCH COURSE PROJECTS

NAVIGATION DEPARTMENT

THE SOLUTION OF AND ALGORITHMS FOR A CELESTIAL FIX BY COMPUTER USING A  
NON-ALTITUDE INTERCEPT METHOD

Researcher: Midshipman 1/C Roger D. Watkins

Adviser: Lieutenant James H. Blaisdell, USN

This project developed a spherical trigonometric solution to the celestial fix which is not dependent on the altitude intercept method or a dead reckoning position. The technique proved workable. The program is in Basic and requires all shots to be simultaneous.

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PRESENTATIONS

NAVIGATION DEPARTMENT

BLAISDELL, James H., Lieutenant, USN, "Computer-Based Education in the Applied Sciences." Paper read at the National Navigation Education Symposium, Kings Point, New York, April 1977.

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## SEAMANSHIP AND TACTICS DEPARTMENT

Commander Joseph M. Quigley, USN, Chairman

Further investigation was conducted into teaching the maneuvering board concept of relative motion at sea, using a mathematical prediction model to forecast student ability and instructor effectiveness. Historically, a significant number of students have had difficulty in grasping the techniques involved in solving ships's relative motion with plots on a polar grid, an exercise necessitating many hours of extra instructions. By using the prediction model, slow students can be grouped with the most effective instructors to maximize teaching efforts.

War-gaming (manual and computer-assisted) has been incorporated into two courses taught by this Department. In the Third Class course, Ship-handling and Tactics, NS252, the manual game has been used to arouse student interest in tactics and platform capabilities. The First Class course, Naval Tactical Warfare Seminar, NS400, has tasked one section to set up computer-aided war-game scenarios. The use of a computer markedly speeds up the game and enables encounters of much greater complexity.

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## MIDSHIPMAN MANEUVERING BOARD CAPABILITY: A PREDICTION MODEL

Researchers: Commander Joseph M. Quigley, USN, Commander James L. Bagby, USN, (Engineering and Technology Department), and Lieutenant Peter W. Korinis, USN

The maneuvering board plot, a method of solving relative motion problems on a polar grid, is taught to the Fourth Class midshipmen. The relative motion problem is a source of confusion to a great number of students resulting in significant extra-instruction time. The ability to solve the relative motion problem must be mastered in order to perform adequately during cruises and in other naval science courses.

At the Naval Academy it is imperative that the prospective Surface Warfare officer be intimately familiar with the maneuvering board and its use.

The prediction model was used during the fall semester 1976 to predict instructor effectiveness. From this prediction analysis, three instructors of different levels of teaching proficiency were given three sections of students during the fall semester of 1976: one that was predicted to have a low aptitude for grasping maneuvering board concepts; one randomly-assigned section; and one predicted to be above average. On the final examination the maneuvering board scores were tabulated for the nine sections.

The results show how an above-average instructor can have a significant effect on students who have been predicted to have difficulty grasping the relative motion concepts of the maneuvering board.

The success of the model was reduced in some cases because of the large standard deviation.

One of the psychological tests which was used as an input into the model was not given to the Class of 1980. The mathematics level, another input, was not in the format previously used, but was interpolated and was considered to be accurate enough for utilization. These problems induced some errors in the model, but since they were minor factors, the model was still considered valid. The whole-man multiple was the most significant factor used.

It is envisioned that the prediction of the slow student can be utilized to forecast learning problems so that the instructor can assign programmed texts or special assignments to prevent a short term pre-tested extra instruction demand.

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## WAR-GAMING IN THE PROFESSIONAL CURRICULUM

Researchers: Commander Joseph M. Quigley, USN, Lieutenant R. Steven Herbert, USN, Lieutenant Robert Mendez, USN, and Assistant Professor Richard A. Pollak (Academic Computing Center)

War-gaming in the Naval Tactical Warfare Seminar, NS400, began during the fall semester of 1977, when one section of students began adapting a Johns Hopkins Applied Physics Laboratory (APL) computerized model. This program, WASGRAM, was designed by APL for use by the Joint Chiefs of Staff. This game has the capability of simulating surface, sub-surface, and air platforms in a fixed scenario on a grid coordinate display. Also employed during the fall semester was a Destroyer/Submarine simulation structured to pit one submarine against one destroyer. Both simulations were unclassified and judged insufficient as tactical training devices. Therefore, in the spring of 1977, using the data base and experience gained from the first two attempts at war-gaming, a somewhat different simulation, NAVTAG, was tested for applicability. This model is primarily designed for table-top use; however, it is apparently easily adapted to computerized use and presents a far more flexible approach to tactical instruction. This was proven during the spring 1977 semester when the table-top game was used in six experimental sections, generating increased student participation, enthusiasm, and tactical awareness. Preliminary work has begun on the NAVTAG computer adaptation and a working model is anticipated to be available for limited use during the fall semester 1978.

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DIVISION OF  
U. S. AND INTERNATIONAL STUDIES

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## AREA-LANGUAGE STUDIES DEPARTMENT

Professor Guy J. Riccio, Chairman

Research activity in the Department during the 1976-1977 period essentially remained at about the level of the previous year, with some evidence at the end of the year of a promised upsurge in research effort in the years ahead. In terms of overall productivity during the year, three faculty members were particularly active, two of whom were engaged in projects originally funded by the Naval Academy Research Council grants. In addition, one midshipman, Class of 1978, enrolled in an independent projects course which because of its Chinese-language requirement represented a unique undertaking at this advanced level.

The faculty as a whole continues to pursue either informal investigation of or specific research projects in a number of areas related to their particular language, culture, or linguistics interests. These include, as heretofore, 16th century German literature and literary criticism, lexical studies in Spanish, contemporary Spanish-American literature, computer-aided instruction in French, current military doctrine of the Soviet Union, church-state relations in the Soviet Union, and, a more recent area of inquiry, military leadership in the People's Republic of China.

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COLLECTION OF BIOGRAPHICAL DATA ON THE MILITARY LEADERSHIP IN THE  
PEOPLE'S REPUBLIC OF CHINA

Researcher: Associate Professor Daniel T. Y. Lee

Sponsor: Naval Academy Research Council

The purpose of this research project is to survey existing and current biographical compilations done outside of China on the Chinese military leadership, and to study the feasibility of developing an automated file on this subject for analytical studies.

Initial surveys conducted during the summer of 1976 proved not only that it is feasible but that there is also an urgent need for such a project in several government quarters. Preliminary investigations have thus far yielded invaluable data; computer programs for this specialized file have since been developed. With this research thus completed, the project is proceeding on its second phase that will include: updating and expanding of existing source materials, translating all materials into English, and inputting materials into computer file.

The Defense Intelligence Agency has expressed a high interest in supporting the continuation of this research effort and, as of this writing (June 1977), the prospects of such funding appear very favorable.

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## THE SATIRE AS A POLITICAL WEAPON IN 16TH CENTURY GERMANY

Researcher: Assistant Professor Michael C. Halbig

The purpose of this research, initiated originally under a Naval Academy Research Council grant in 1975-1976 and centering on the neo-Latin poetry of three 16th century German humanists, is to develop some of the forms of the new German Humanism that was winning momentum in the early 1600's and overcoming the medieval scholasticism that still dominated the Church, monastic orders, and the universities of Germany.

Many of the impulses for a new intellectual atmosphere at this time came from Italy -- directly, as Italian courtiers brought to Northern Europe's rulers the new outlook of the Cinquecento, and, in somewhat modulated fashion, as Germans went south to study and returned north to adapt the new ideas they had encountered to their own German surroundings. The researcher proposes to examine primarily the writings of two Germans who were a central part of this latter development -- Ulrich von Hutten and Johannes Reuchlin. In defense of a more liberal outlook, these two became involved in a conflict that set them dead against traditional scholasticism and, not inconsequentially, against Germany's monastic orders and theological faculties in perhaps their most degenerate period. A series of counterfeit letters, ostensibly representing the correspondence between some of these monks and theologians, though actually penned by Hutten and friends, was published in 1514, to support Johannes Reuchlin, who was at this time under the furious attack of certain ecclesiastical authorities. (Reuchlin, a prominent legal scholar and German Humanism's preeminent Hebrew scholar, had criticized a move to burn all Jewish religious books in Germany, and a counter-attack by the theological faculty in Cologne sought to censure Reuchlin. In this attempt, they appealed all the way to Leo X in Rome, who, incidentally, turned down their request.)

These letters -- the "Letters of Obscure Men" -- are remarkable not only for their effective satire of a dissolute monasticism. So great was their popular appeal that they became historically important as political tracts preparing the way for the Reformation five years later (they were published in 1514). Additionally, these letters draw the line between two periods of intellectual history, medieval scholasticism and 16th century humanism, as do few other individual documents. This divergence, interestingly, emerges as virtually a conflict of generations -- between young and old, students and teachers. The researcher proposes, in particular, to develop just what the "old" and "new" orders stand for as seen through



the pages of the "Letters" and, beyond that, to examine their use of counterfeited correspondence to satirize the perceived shortcomings of their opponents.

This study will shortly be brought to completion, with submission of the manuscript to a scholarly journal expected in the fall of 1977.

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A CRITICAL STUDY OF SOME IMPORTANT DOCUMENTS OF THE PEOPLE'S REPUBLIC OF CHINA

Researcher: Midshipman 2/C Murray S. Donovan

Adviser: Associate Professor Daniel T. Y. Lee

The purpose of this project was to pursue an indepth study of some important documents published in the People's Republic of China during the period of 1954 and 1975. All selections are in Chinese and are representative pieces of official literature on various important topics: political, social, economic, military, as well as ideological. It was essentially an effort to develop a command of the Chinese language adequate for firsthand understanding of Chinese materials as a basis for research in the field of Far Eastern studies.

This project was accomplished with a total of 15 oral presentations, including a contrastive analysis of the "old" and "new" constitutions of the People's Republic of China.

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PRESENTATIONS

AREA-LANGUAGE STUDIES DEPARTMENT

HALBIG, Michael C., Assistant Professor, "Teaching Communication Skills with Audio-Visual Technology." Paper read at the Spring meeting of the Middle States Association of Modern Language Teachers, Annapolis, Maryland, 2 April 1977.

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## ECONOMICS DEPARTMENT

Associate Professor Clair E. Morris, Chairman

The Economics faculty, which consists of seven civilians and seven officers, has continued its record of fine scholarly activity during this reporting period. Three members have initiated projects under the sponsorship of the Naval Academy Research Council. Much additional independent research has been vigorously pursued by those who are making excellent progress in establishing a wide reputation in the Economics discipline. Diverse methodology has been used to investigate a wide array of topics ranging from structural transformation of an agricultural economy to small business failure and the economic effects of vocational training in the military. Publications and presentations are representative of the strong research effort that has been made, an effort that will continue in the future.

The Economics faculty convincingly believes in the firm link between serious research and good teaching. It has demonstrated time and time again that the professionalism associated with research results in enthusiastic teaching in the classroom.

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## THE EFFECT OF EDUCATION ON EARNINGS -- A COMPARISON BETWEEN 1960 and 1970

Researcher: Assistant Professor Rae Jean B. Goodman

Sponsor: Naval Academy Research Council

During the 1960s, the federal government instituted and promoted programs with the expressed purpose to equalize economic opportunity and alleviate income disparities. The research proposed here is to investigate the earnings-education relation in 1960 and 1970 and to determine whether the rates of return to education have changed significantly over the decade. The research will also attempt to determine both in absolute and relative terms the change in the earnings-education relations for the total labor force and for the labor force disaggregated by sex and by race. In particular, the impact of federal government policies on the changes in the education-earnings relation and the rate of return on investment in human capital will be investigated.

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## THE ECONOMIC IMPACT OF MILITARY VOCATIONAL TRAINING

Researchers: Associate Professor Roger D. Little and Assistant Professor J. Eric Fredland

Sponsor: Naval Academy Research Council

The problem the researchers are addressing is the lasting value of military vocational training to ex-servicemen in their civilian occupations. The researchers are comparing the socioeconomic characteristics of those who have had and presently use military vocational training with those who have never had such training. The researchers are applying multiple regression analysis in their comparisons to allow for the influence of other variables which affect earnings. The data being used is the National Longitudinal Survey. The data tapes contain survey data on 5000 men ages 45-59 in 1966, and 5000 men ages 14-24 in 1966. The researchers are examining these cohorts separately, beginning with the older cohort.

This work has resulted in a paper presented at the Eastern Economic Association in April 1977, entitled "The Long Term Effects of Military Vocational Training." It concludes that, "The results of the preliminary analysis of the long term impact of military vocational training presented here are mixed. It seems relatively



clear that a premium accrues to the use of vocational training for men in mid to late careers, and it is also apparent that those who use armed forces training do about as well as those who use other training. On the other hand, we were less successful, though not completely unsuccessful, at discovering significant effects for armed forces training itself, even when the data were disaggregated by industry and occupation."

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## ANALYSIS OF PUBLIC BADS

Researchers: Assistant Professor J. Eric Fredland and F. D. Tinari  
(Seton Hall University)

The purpose of this research is to examine theoretically the nature of "public bads" (negative external effects) which arise to erode certain collectively consumed facilities, once these facilities are provided. The facilities particularly subject to this erosion are recreation and cultural facilities.

The work thus far has resulted in a paper presented to the Eastern Economic Association in April 1976, entitled "A Taxonomy of Public Bads Arising from the Use of Collectively Consumed Facilities" and a paper "On the Erosion of Public Facilities" tentatively accepted for publication by the Review of Social Economy. The researchers are currently developing a mathematical model of user utility for a particular kind of public facility (a golf course) subject to a variety of constraints.

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## SURVEY AND CRITIQUE OF ECONOMETRIC STUDIES OF HOUSING MARKETS

Researcher: Assistant Professor J. Eric Fredland

The objective of this work is to survey the literature on econometric models of the housing sector of the economy of the United States. All literature since a survey done by Grebler and Maisel (1963) is included. The equations of the housing sector of all the major econometric models of the U. S. economy are being examined. A general critique of this literature is being written, covering the relation between economic theory and this econometric work, the availability and use of data relevant to the housing sector, the estimation techniques used in the econometric work, and the ability of the models to address policy questions. To date a bibliography has been compiled and the survey has been drafted.

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THE STRUCTURAL TRANSFORMATION PROCESS IN AN AGRICULTURAL SUB-REGION:  
A CASE STUDY

Researcher: Assistant Professor Arthur Gibb, Jr.

This is a study of the possibilities for alleviating unemployment and urban slum conditions in developing nations by fostering a more dispersed pattern of human settlements (urban centers) and faster, more equitable rural growth.

The general scheme of the research is to attempt to identify the causal relations underlying the creation of new jobs in the small urban centers of agricultural regions. Structural transformation analysis suggests that job creation is a function of rising incomes and output and that the equitability of the distribution of the income is crucial to the rate of employment generation.

Regional economic techniques are utilized to identify the direction of the causation involved and the spatial organization of the industries in which the employment is created. The resulting pattern of rural urbanization is analyzed in terms of what physical infrastructure, public services, and financial institutions are required at each tier of the urban center.

Policies are suggested that would serve to foster local employment and industry growth in an optimally dispersed manner.

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FREDLAND, J. Eric., Assistant Professor and Clair E. MORRIS, Associate Professor, "A Cross-Section Analysis of Small Business Failures," American Journal of Small Business, 1 (July 1976), 7-13.

Considerable federal assistance is provided to "small" business. The rationale for this assistance is in part that small firms face disadvantages in competing in the market place against larger more diversified firms. This paper presents results of an empirical examination of business failures, defined as those firms involved in bankruptcy or otherwise closing with loss to creditors. The purpose was to study the relationship between selected characteristics of firms, particularly size measures, and their propensity to fail. The most interesting result that emerged was that size of firm and likelihood of failure are not strongly correlated.

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MORRIS, Clair E., Associate Professor, "From Adam Smith to Lord Keynes: The Concept of Stability Revisited -- Comment," Atlantic Economic Journal, 5 (March 1977), 97.

The concept of a methodology that unifies a study of all forces--social, political, economic, etc.--that affect the behavior of man is particularly appealing. We are indebted to Professor Rugina for emphasizing the need for such a methodology and for breaking new ground in an attempt to provide one. Even though he has not been totally successful, he has challenged us to think in new directions that will ultimately be rewarding. Further progress will likely occur when he places less emphasis on the ideas of Walras and assimilates a greater proportion of currently accepted economic doctrine into his methodological models.

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PRESENTATIONS

ECONOMICS DEPARTMENT

FREDLAND, J. Eric, Assistant Professor and Roger D. LITTLE, Associate Professor, "The Long Term Effects of Military Vocational Training." Paper read at the Eastern Economic Association Meeting, Hartford, Connecticut, April 1977.

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GOODMAN, Rae Jean B., Assistant Professor, "The Earnings Function: A Comparison 1960 to 1970." Paper read at the Western Economic Association Meeting, Anaheim, California, June 1977.

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LITTLE, Roger D., Associate Professor, "The Labor Force of Anne Arundel County." Paper read at symposium on the Economic Characteristics of Anne Arundel County, Annapolis, Maryland, January 1977.

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## POLITICAL SCIENCE DEPARTMENT

Professor John R. Probert, Chairman

The faculty of the Political Science Department, consisting of eleven civilians, five officers, and one Foreign Service Officer, undertook a total of 31 distinct research or research-related projects during 1976-1977. Four of these were sponsored research with support coming from the Chief of Naval Development, the Advanced Research Projects Agency, the Naval Academy Research Council, and the Naval Facilities Command. Such diverse subjects as the utilization of computer data banks in writing environmental impact assessments and statements, international transaction flows, the use of naval technology in foreign environmental programs and Singapore in ASEAN, the Commonwealth of Nations, and the United Nations were involved. Independent research projects topics included the evolution of Ostpolitik: 1961-1971; international event flows; and Brazilian behavior in the United Nations.

Twelve research course projects were undertaken by midshipmen under faculty guidance. Of these, five were done with the specific purpose of enhancing each midshipman researcher's knowledge of a subject area he would discuss in the 1977 Naval Academy Foreign Affairs Conference. Subjects researched ranged from Soviet naval growth to multi-national enterprises, and the Palestine Question, among a variety of others.

Methodological variation also characterized the Political Science Department's research effort, including descriptive, historical, and normative approaches, as well as the behavioral with its emphasis on the empirical with extensive quantification. The Department's unparalleled computerized data resources have been most conducive to the latter approach and represent a continuing inducement to research along those lines.

The research effort of the Department in form of output included one textbook on Latin America and the international political system, as well as numerous papers presented and participation in panels at learned societies, lectures to outside groups, articles in professional journals, and formal reports to sponsors.

Enhancing as it does the academic reputation of the Naval Academy, the Department's substantial research effort also retains and adds to the momentum and quality of the Department's teaching effort. The faculty, kept abreast of developments in its various fields of expertise by its research, carries its expanded knowledge into the classroom, enlivening and updating discussion and sparking midshipmen interest and learning thereby.

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## MATCHING COMPUTER ENVIRONMENTAL DATA SYSTEMS WITH POTENTIAL USERS

Researcher: Associate Professor Charles L. Cochran and Assistant Professor Frederick A. Skove (Computer Science)

Sponsor: Naval Academy Energy-Environment Study Group  
(Naval Facilities Engineering Command - Code 032D)

The purpose of this project was to determine whether or not data files were in existence that were sufficiently developed to provide useful information on such projects as writing Environmental Impact Assessments and Environmental Impact Statements. It was determined that the Army Civil Engineering Research Laboratory (CERL) in Champaign-Urbana has developed several programs designed for this purpose. These appear to be the most likely to be adaptable to Navy needs.

CERL has developed three specific programs which were examined in this study. The Environmental Impact Forecast System (EIFS) is designed to assess the economic and social impact of construction, mission change, training, and operations and maintenance programs. The Environmental Impact Computer System (EICS) provides a basis for identifying environmental impacts and suggests means by which harmful impacts may be mitigated. The Computer-Aided Environmental Legislative Data System (CELDS) is designed to provide easy access to the abstracts of key or relevant federal and state laws as regards environmental protection.

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## THE GENESIS AND EFFECT OF AMERICAN GEOPOLITICS: 1939-1941

Researcher: Lieutenant Thomas R. Fedyszyn, USN

Sponsor: Naval Academy Research Council

This research project is an in-depth study of the creation of American attitudes and opinions concerning our impending intervention in the Second World War, and their long term effects.

Its significance resides in the fact that the campaign which the "interventionists" waged to persuade America to go to war against the Axis laid the foundation for the universalization of the U. S. defense commitment shortly thereafter. The concept of America's "expanded security" will be analyzed and its applicability evaluated.

SPONSORED RESEARCH

POLITICAL SCIENCE DEPARTMENT

The persuasive techniques of three "interventionist" factions will be documented and compared:

- a) Influential Public affairs periodicals (e.g. Foreign Affairs, Atlantic, Annals., etc.),
- b) Roosevelt Administration pronouncements, and
- c) Local newspapers of fifteen upstate New York cities and towns.

The data collected to date indicate that these opinion-making groups had unique styles and frequently strayed from recommended techniques of "war propagandizing".

Research on this project is still in progress.

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INTERNATIONAL TRANSACTION FLOWS: DIPLOMATIC REPRESENTATION AND TELECOMMUNICATIONS

Researcher: Professor John A. Hutchins

Sponsor: Advanced Research Projects Agency (ARPA)

This project deals with the quantitative measurement of world-wide diplomatic representation and international telecommunication tabulated dyadically. The data and the manipulation of them are completely computerized. They are unique and form integral parts of the basic course in international relations in the Political Science Department.

Work still to be accomplished is to bring both files up-to-date. Diplomatic representation now has some four years of data and is nearly complete through 1976. Telecommunication, however, requires extensive efforts to obtain recent data from various governmental agencies, both in the United States and abroad.

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## USE OF NAVAL TECHNOLOGY IN FOREIGN ENVIRONMENTAL PROGRAMS

Researcher: Professor Rocco M. Paone

Sponsor: Naval Academy Energy-Environment Study Group  
(Chief of Naval Development, Code MAT-0341)

The purpose of this project was to analyze the role of foreign navies and naval technology in national pollution abatement programs. Among the navies studied were those of NATO nations, Brazil, Israel, Taiwan, Chile, the Republic of South Africa, USSR, Sweden, and France. The methodology in the research involved much contact with U. S. defense attaches and science professors abroad, correspondence with foreign diplomats and naval officers, and study of published articles. Most of the research is related to water and air pollution abatement and the question of existence of naval environmental specialists.

As a result of this research, the following conclusions were reached:

1. Foreign nations are more interested in industrial development than in pollution abatement.
2. Most navies have technicians who handle pollution abatement aboard ship and some engineering officers who have training in environmental programs, but no environmental specialists.
3. Most navies have an input, direct or indirect, into the decision-making process on national legislation relating to environment programs that might affect the Navy.
4. Most navies, barely most, are responsible for policing the territorial waters for violations of national environmental programs.
5. Rarely do foreign nations use naval technology or the knowledge of naval engineers in national pollution abatement programs.
6. Foreign naval officers do not undertake research on pollution abatement, rarely have specified environmental budgets, and often function in the capacity of testing new mechanisms that are designed to reduce pollution aboard ship.
7. The U. S. Navy environmental programs are much more advanced than those of the foreign navies studied.

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POLITICAL PARTICIPATION IN INTERNATIONAL ORGANIZATION: SINGAPORE IN  
ASEAN, THE COMMONWEALTH OF NATIONS AND THE UNITED NATIONS

Researcher: Associate Professor Robert L. Rau

Sponsor: Naval Academy Research Council

Singapore has earned the reputation of being one of a limited number of developing nations capable of political and economic development and progress unassisted by aid and other forms of support from the developed world. This study discusses Singapore's activities, policies, and objectives in three international organizations. Through this study some insight is gained as to how and why Singapore has achieved such an enviable record.

The study includes analysis of Singapore's policy in the Commonwealth, the United Nations and ASEAN and the methods and factors central to successful representation in these organizations.

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## THE EVOLUTION OF OSTPOLITIK: 1961-1971

Researcher: Foreign Service Officer Jack Mendelsohn

This study, written for an Institute on East Central Europe, Columbia University certificate, traces the history of OSTPOLITIK and its impact on Eastern Europe during the decade immediately prior to the signing and ratification of the Bonn-Moscow and Bonn-Warsaw Treaties of 1970. It attempts to show how a complex interplay of domestic factors and international politics drove West Germany, the Soviet Union, and Poland to seek some sort of accommodation following the 1968 Czechoslovak invasion. West Germany was seeking to ensure that it would not be excluded for the general detente movement; the Soviet Union was hoping in some manner to control the increasing appeal to its allies of the SPD "opening to the East"; and Poland was counting on improved relations with West Germany to help alleviate its own domestic, political, and economic problems.

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## ANALYZING TRENDS AND PATTERNS IN INTERNATIONAL EVENT FLOWS

Researcher: Assistant Professor Rodney G. Tomlinson

This study, the researcher's doctoral dissertation, argues that quantitative research in the political behavior of nations may create statistical artifacts that mask or misrepresent the true pattern of behavior. Hence the researcher proposed that detailed examination of the geometric structures of political events could be a useful mid-stop between traditional qualitative analysis and pure statistical descriptions. A geometry of event flows was proposed and twenty-three cases of bi-lateral relations examined.

By merely "eye-balling" the event flows, patterns were observed which could not be described by numeric methods. Some appeared more than once, suggesting that behavioral change might have some generalizable characteristics. For example, the settlement of disputes usually had "penals" where the behavior pattern transitioned from one of routinized hostility through an interval of nearly random behavior (political sparring) to a pattern of seemingly consistent cooperation.

The human eye, with its enormous ability to integrate apparently disparate patterns into related systems, was suggested as an alternative method to formalist statistical studies.

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## BRAZILIAN BEHAVIOR IN THE UNITED NATIONS

Researcher: Assistant Professor Rodney G. Tomlinson

This research developed the supporting data for the observations and analyses in Chapter 6 of a forthcoming book on Brazilian Foreign Policy by Wayne A. Selcher. Major tasks included identification of information structures and the preparation of the necessary computer programs. These were accomplished by the researcher.

It was found that Brazil has moved toward an independent stance on major world issues. While initially a solid member of the western bloc in the early post-WW II years, Brazil moved toward a "Latin consensus," followed by an independent position. Brazil remains aloof, agreeing with no major United Nations bloc (West, Soviet, Third World) consistently as to be called a member. Brazil however, aligns herself more with the Third World than with the U. S./Western group. It is notable that Brazil tends to abstain on controversial issues or when cross-pressured by opposing blocs.

If the United Nations voting behavior can be considered representative of foreign policy objectives, then we may suggest that Brazil is attempting to maintain a low-profile, conciliatory, independent position in world affairs. This is a most interesting phenomena that is anomalous to her physical size and economic importance.

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## THE PRC IN SOUTHEAST ASIA

Researcher: Midshipman 1/C Thomas Arminio

Adviser: Professor Rocco M. Paone

The purpose of this research was to analyze the activities of the People's Republic of China in portions of Southeast Asia and ascertain the degree, if any, of expansion intended by the PRC in that region.

The relations between the PRC and Laos, Cambodia, and Vietnam were surveyed in depth. Using a number of the data banks in the Political Science Department, the researcher analyzed the economic, financial and diplomatic relations of the PRC with each of the three nations in addition to China's arms sales and foreign assistance programs in those countries. The study also covered an analysis of issues over the Paracels and Spratlies Islands as well as an identification of the United Nations' voting patterns among the four countries. The study concludes that the PRC aims at closer relations with Laos, Vietnam, and Cambodia and that these three countries have adopted a policy of cooperative aloofness in relation to the PRC. It was also concluded that the PRC, particularly under the new regime, has become less dogmatic and increasingly pragmatic in its approach to international affairs.

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## SOVIET NAVAL GROWTH 1952-1976

Researcher: Midshipman 1/C Thomas Breyer

Adviser: Assistant Professor Rodney G. Tomlinson

This three-credit course was designed to provide Midshipman Breyer with practical experience in the technical development of computerized information handling systems and systematic analysis of military-political data. Since he will enter the Naval Intelligence community upon graduation, this exercise was undertaken at the suggestion of the Intelligence Detailer, Bureau of Naval Personnel.

As the vehicle for the exercise, Midshipman Breyer undertook to study the structure and design of our existing (but unverified) data file of Soviet Naval Fleet Units, to evaluate its accuracy, update it for the years 1973--1975, and prepare a set of data management programs suitable for use by an intelligence analyst assigned to a large staff.

He found that even carefully gathered data, as represented by the existing data base, can have many errors if not constantly monitored by a careful analyst. Further, he observed that longitudinal analyses (year-to-year) uncovered trends and patterns in Soviet ship design philosophy that are not easily seen by looking at inventories at single points in time. For example, the trend toward medium-tonnage heavily-armed surface units like the KRESTA, KYNDA and KARA classes was established well before the Cuban Missile Crisis (1962) and suggests that the USSR planned a blue-water fleet to challenge the U.S. Fleet in the early post World War II years.

Midshipman Breyer prepared a set of computer programs for the update of the data file. He coordinated the review and verification of the existing data file.

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#### MULTI-NATIONAL ENTERPRISES AND WORLD INTERDEPENDENCE

Researcher: Midshipman I/C Christopher T. Burnett

Adviser: Associate Professor Philip A. Mangano and Assistant Professor Arthur Gibb, Jr. (Economics)

This project was undertaken by the researcher: (a) in conjunction with his role and special concern as a delegate to the recent Naval Academy Foreign Affairs Conference (NAFAC); (b) for independent research course credit "Topics in Political Science," and (c) as a matter of strong personal interest.

The project was completed in May 1977. Secondary guidance and assistance to the researcher were also provided by Assistant Professor Arthur Gibb, Jr. of the Economics Department.

The purpose was to demonstrate how the multinationals become one of the main forces tending to knot large parts of the world more closely together, and bringing benefits to both the country (countries) of incorporation and those in which they conduct their affairs.

Midshipman Burnett first described and analyzed the structural and operational characteristics of major multinational enterprises in general. He concluded that in their decision-making process, they rise above the narrower nationalistic tactics of nation-state governments while adapting flexibly to national economic policies set by governments.

The balance of the study consists of case studies of the practice and experience of such multinationals as the copper enterprises in Chile and International Business Machines (IBM) in Europe and elsewhere. These tend to show that such enterprises (particularly in the case of IBM) have decentralized their management and decision-making processes so that host states (or governments) in the Third World and elsewhere, often reap as much advantage from their presence as the country of their incorporation.

The research rested on substantial use and analysis of statistics put out by governments and corporations. Primary and secondary source materials were both extensive and authoritative. The political dimension was examined and weighed, though not overly stressed.

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#### THE FUTURE FRAMEWORK FOR WORLD ORDER: REGIONALISM OR UNIVERSALISM

Researcher: Midshipman 1/C James J. Dranchak

Adviser: Associate Professor Philip A. Mangano

This research was done: (a) to prepare Midshipman Dranchak for participation in round-table discussions at the 1977 Naval Academy Foreign Affairs Conference; (b) to meet requirements of the three-hour credit course (featuring independent research), "Topics in Political Science"; and (c) to further the researcher's own interest in the subject following earlier work in the course on international organization.

Midshipman Dranchak came to grips with a question which has pre-occupied international affairs scholars and specialists recently: Looking ahead over the next 20-25 years, is emphasis on regionalism or on world-wide organization likely to contribute more to a viable system of world order? He used ample primary and secondary source materials bearing on: (a) political and security aspects; (b) economic, technical and other functional arrangements tending to stress integration or interdependence; and (c) the interaction between regional and universal mechanisms and organizations concerned with security or functional problems.

Applying the method of comparative analysis, the researcher drew a distinction between the relative lack of success of the United Nations in becoming a consistently dependable guarantor of the peace and its progressive assertion of a leading role in dealing with world-wide economic integrationist forces (especially in Europe). In favor of the world-wide or universalist approach, the study maintains that it alone is capable of coping with such phenomena as continuing East-West tensions and the newer North-South (developed countries vs. Third World) split over the proper approach to reshaping the world economic order.



The study concluded that, only by judicious and persistent use and development of international organization at both levels, can genuine progress toward a more effective and peaceful world order be hoped for over coming decades.

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#### EUROPEAN SECURITY: THE EAST-WEST ALLIANCES

Researcher: Midshipman 1/C Peter J. Finley

Adviser: Foreign Service Officer Jack Mendelsohn

Midshipman Finley read widely in available unclassified literature on the current state of the European military balance, taking into consideration the ground, air, and nuclear forces of both NATO (North Atlantic Treaty Organization) and WTO (Warsaw Treaty Organization). He also examined how this balance relates to each alliance's position on mutual and balanced force reductions (MBFR) in the central European sector.

After careful research and analysis, he concluded that the military balance in Europe is not as disadvantageous to NATO as the figures indicate. NATO enjoys several significant advantages: in technology, in logistics, and in the ratio of combat to support troops at the divisional level. In addition, NATO has the potential to generate a number of ground personnel in Central Europe in a crisis situation and, with the inclusion of currently uncommitted (and uncounted) forces of the United Kingdom, France, and Denmark, the Western allies would have a greater number of troops available than would the WTO.

Regarding MBFR, Midshipman Finley concluded that the main motivation of the negotiations is political rather than military and that the MBFR talks are unlikely to progress before a new strategic arms limitation (SALT) agreement is reached.

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#### AN ANALYSIS OF ENTERING FOREIGN SERVICE OFFICERS 1966-1976

Researcher: Midshipman 1/C Dennis R. Grimes

Adviser: Professor John A. Hutchins

This is a piece of original research and may well be worth publishing after some minor revisions and corrections are made. Basically, it was accomplished by taking the magnetic tape of the Foreign Service Officers profiles from the data processing center at

the Department of State. Midshipman Grimes was able to transfer the data from State's IBM computer to our GE-Honeywell Time-sharing system, no mean feat in itself. He then "massaged" it with several statistical routines to produce findings of considerable interest. He found an increasing number of females being commissioned as Foreign Service Officers. More were coming from the West, and the Ivy League School domination seemed to be slipping. California residents were the highest in number. As for college majors, political science was first, followed closely by history in both the graduate and undergraduate schools.

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#### THE FUTURE ROLE OF THE NORTH ATLANTIC TREATY ORGANIZATION

Researcher: Midshipman I/C Richard Hansen

Adviser: Lieutenant Thomas R. Fedyszyn, USN

The primary objective of this research project was to examine the utility of the North Atlantic Treaty Organization (NATO) as a vehicle for providing military security for non-Communist Europe and the United States. A secondary objective dealt with the determination of the suggested American role in this organization.

NATO was evaluated in terms of its ability to provide collective security for its members, and all other considerations were deemed secondary. A theoretical discussion of this concept yielded the fact that all successful attempts at collective security are characterized by: (a) an external threat perceived by the alliance members, and (b) the capacity of alliance members to work together.

The study of recent books and periodicals proved conclusively that the Soviet Union has massed sufficient military force in Eastern Europe as to pose a serious military threat to NATO countries. However, Europe's perception of this threat, as operationalized by an analysis of European defense spending trends as well as by public opinion polls, is that it is not very serious. Through the use of several case studies it was further determined that these states have met with success only in cooperative endeavors which are distinctly non-military in nature. In security matters, their record of cooperation is characterized by the futile twenty-five year battle to standardize NATO's weaponry.

For reasons more psychological than economic or military, it was concluded that the United States should remain in the alliance. However, the future efficacy of this alliance in matters of security was seriously questioned.

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LAW OF THE SEA NEGOTIATIONS, AND THE DEVELOPING U. S. POSITION ON  
RESOURCES OF THE SEA-BED

Researcher: Midshipman Kevin P. O'Keefe

Adviser: Associate Professor Philip A. Mangano

This project was designed to enable Midshipman O'Keefe to build upon an earlier, preliminary study he had made as a student in the course on "International Organization," and to prepare him for participation in the 1977 Naval Academy Foreign Affairs Conference, in group discussions of Ecology and Resources Development. The methods used included drawing upon extensive source materials such as special studies, a wide selection of periodical articles, documents published on the successive Law of the Sea Conferences, interviews with several official U. S. participants, and regular consultation-discussion sessions with the Faculty Adviser. The study was completed for course credit in May 1977.

It was divided into three main parts. The first part considered the nature of the resources of the sea-bed, estimates of their economic potential and value, and of the progress in needed technologies. The second part, after pointing out the absence of generally agreed and applicable international law, traced the course of negotiations of those questions at the successive rounds of the conference on Law of the Sea. The final part focused on the evolution of the U. S. position, bearing in mind the apparent inability of the international conferences to work out generally acceptable principles, and mechanisms, for regulating the use of what has been called the "Common Heritage of Mankind."

Since early agreement seems most unlikely, Midshipman O'Keefe concludes that the U. S. should be prepared to initiate deep-sea mining on its own account, if only to push the international negotiations to a final conclusion, granted that such a course carries certain risks.

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THE PALESTINE QUESTION AND ZIONISM

Researcher: Midshipman 1/C Chris L. Pashos

Adviser: Associate Professor Philip A. Mangano

This project was designed to permit Midshipman Pashos to explore in considerable depth the nature, evolution and present status of Zionism and the Palestinian movement, and their interaction, in the tangled and continuing Middle East conflict. He pursued this research also, in part, in preparation for participation, as a delegate, in the 1977 Naval Academy Foreign Affairs Conference, and as a member of the panel dealing with "The Human Dimension" in regional and global problems.

His written study includes a review of the way in which this problem has developed over the past three decades, and an examination of the main issues that must be resolved in any lasting peace settlement. It also examines and assesses some of the possible, reasonable solutions which most objective scholars and observers regard as workable and desirable.

The research was based on thorough and wide-ranging use of source materials. These included: special studies and monographs; articles from reputable periodicals and newspapers; official U.S. documents, speeches, etc.; UN documents, resolutions, press releases and reports; official Israeli and Arab state (or organizations') publications and reports; and speeches and other texts by other world leaders or spokesmen.

Building upon historical review of the Zionist-Palestinian Arab conflict since the end of World War II, the study then emphasizes the continuing nature of that conflict in terms of the ideas, doctrines, goals and motivations of the Israeli (Zionist) leaders and the Palestinian (Arab) leadership which has emerged since the 1967 war, but more especially since the 1973 October war.

The thrust of the study can be summarized in a few words. It finds, essentially, that Zionism - having achieved its own form of "self-determination" for the Jews in what was Palestine, adequate and early provision must now be made for "self-determination" for the Palestinian Arabs in at least a reasonable portion of their own traditional homeland.

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#### NATURAL RESOURCES: THE EFFECT OF THE U. S. STRATEGIC POSTURE IN THE NEXT DECADE

Researcher: Midshipman 1/C G. Sean Rice

Adviser: Commander Joseph F. Hoffman, USN

This project was undertaken by the researcher: (a) in conjunction with his role as delegate to NAFAC 77, The U.S. Naval Academy Foreign Affairs Conference; and (b) as an independent research course credit ("Topics in Political Science").

Since World War II the industrialized world has been attaining a higher level of prosperity that has been shared in the most part by the more developed countries, even those that are centrally planned. To maintain this progressive betterment of the human condition, continuous supplies of energy and raw materials have been required.



This foundation for an increased standard of living was shaken by the (OAPEC) oil embargo of 1973-1974, and more recently by the strident demands of the Third World countries who would like to alter the economic system more to their benefit. These demands have been put forward in the United Nations Committee for Trade and Development (UNCTAD) and in attempts to emulate the oil cartel.

Midshipman Rice proposed that in the long term future more and more of the United States' foreign policy is going to be primarily concerned with economic matters. Research was done on studies and reports completed by the United Nations, the Bureau of Mines, and the National Commission on Materials Policy in order to determine U.S. usage, both present and projected, of critical raw materials. This study delineates those resources that will be in short supply, where our most favorable future sources must be, and recommends that bilateral actions be taken with these countries to insure future supplies. The crux of the raw material problem is not raw materials but the continued availability of cheap sources of energy. A coherent energy policy between all developed countries is a prerequisite.

A review of the Third World was made and then rejected as destabilizing to the economic world order as too restrictive. The problem of resource allocation will not be solely economic, but primarily political. Economics and politics have become inextricably interwoven and will become more so in the future.

The report concludes that the United States, in conjunction with other friendly developed countries, must (a) have a coherent energy policy; (b) conceive a long(er) term common growth policy; (c) foster growth of international trade and development; and (d) develop alternate energy sources. Unfortunately, the researcher does not believe that these actions will take place, due primarily to the ineffectiveness or myopia of Congress.

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#### COVERT ACTIVITIES WITHIN THE U.S. INTELLIGENCE COMMUNITY: PAST, PRESENT AND FUTURE

Researcher: Midshipman 1/C James P. Wisecup

Adviser: Foreign Service Officer Jack Mendelsohn

Midshipman Wisecup read widely in the available literature on the question of the involvement of the U.S. intelligence community in covert operations. He reviewed the legal basis for the intelligence establishment, traced its evolution, and, based on the Senate and House Committee and other reports, cited a number of examples of clandestine para-military and political activities.



After discussing various proposals for the reorganization of the intelligence community to avoid future excesses or abuses, he concluded that there would be no rapid changes inflicted on either the CIA or the overall intelligence establishment. There seems to exist a general consensus that secrecy is required in certain matters involving national security and that the solution to the abuse of secrecy in intelligence operations appears to be in the closer regulation of covert activities, either through congressional oversight or by the eventual thoughtful reordering of the intelligence community.

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THE POLYGRAPH: ITS USE BY MILITARY LAW ENFORCEMENT AUTHORITIES,  
RELIABILITY, AND VALIDITY

Researcher: Midshipman I/C Mark D. Worrilow

Adviser: Lieutenant J. Gregory Wallace, JAGC, USNR

Midshipman Worrilow's purpose was to discover what criteria were necessary to show that the polygraph was a reliable investigative tool and to compare the training and practices of the Armed Forces with those of civilian examiners.

He found that, as the science of psychophysiology grows and matures, the interpretation of the results of polygraph examinations is more readily accepted by legal authorities; however, even within the field of polygraphy, there are strong differences of opinion caused by the methods of statistical compilation. It is believed that the polygraph is valid and reliable when used by a carefully trained and experienced operator; however, it is important to understand that deception cannot positively be determined in every case. Therefore, one must allow an ample percentage of inconclusive tests, perhaps 10 to 15 percent of the examinations given. If those tests which are inconclusive are eliminated from statistical compilation, then the results of the polygraph may be valid as high as 95 to 99 percent of the time.

Midshipman Worrilow also discovered that the military polygraphers are among the best trained and most experienced in the country. The training course and required refresher courses are extensive and thorough. The regulations under which polygraph examinations are conducted are strict and well-reasoned. The entire profession of polygraphers respects the standards of the military law enforcement officials in this field. As a result of this standardization and training, it is the practice for military prosecutors to drop charges once a person has been cleared by the polygraph, even though the results of such examinations are not admissible in court-martial. He concluded that, in view of this practice and the current inclination of some civilian courts to accept polygraph results, the legal acceptance by military courts might not be far away.

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PUBLICATIONS

POLITICAL SCIENCE DEPARTMENT

ATKINS, G. Pope, Associate Professor, Latin America in the International Political System, The Free Press, New York, 1977.

The author analyzes Latin America as a regional subsystem of the total international political system. This systems approach offers a unifying framework for examining the many facets of Latin American international politics; inter-Latin American relations and Pan-American relations; the foreign policies of the Latin American states and the Latin American policies of the United States, the Soviet Union, China, and Western European nations; and the role of non-governmental bodies such as international labor and business associations, the Roman Catholic Church and guerrilla organizations. Latin American participation in international organizations is also discussed.

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RAU, Robert L., Associate Professor, "Neutralization and National Interest: A Comparative Analysis of the Recent Foreign Policies of Indonesia, Malaysia and Singapore," Annals of XXXIX International Congress of the Orientalists, L'Asiatheque Paris (December 1976), 160-179.

This paper discusses the concept of neutralization as specifically applied by Malaysia in 1973-1974 in the proposed "neutralization of Southeast Asia." The analysis includes the published perspectives of Singapore and Indonesia.

The reactions of the U.S., USSR, PRC, and Japan to the concept are developed and included in the closing portions of the study.

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FITZGERALD, John A., Associate Professor. Two book reviews, The Politics of Weapons Procurement: The Role of Congress and Making the MIRV: A Study in Defense Decision-Making in Journal of Political and Military Sociology, 5 (Spring 1977), 144-147.

\*\*\*\*\*

HUTCHINS, John A., Professor. Book review of Braziola, Sonia Silva; Berner, Regina Mello and Gomes de Matos, Francisco. Portugues do Brasil para estrangeiros. Sao Paulo, Brazil, 1975. Published in Hispania, (September 1976), 564-565.

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PRESENTATIONS

POLITICAL SCIENCE DEPARTMENT

ATKINS, G. Pope, Associate Professor, "Mutual Security and the Changing Inter-American System: An Appraisal of OAS Charter and Rio Treaty Revisions." Paper read at the U.S. Army War College, Military Symposium 1977, 20 January 1977.

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FITZGERALD, John A., Associate Professor, "Who Goes to the Naval Academy?" Paper presented at the annual meeting of the Inter-University Seminar on Armed Forces, Maxwell Air Force Base, Montgomery, Alabama, October 1976.

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PAONE, Rocco M., Professor, "Congress, Foreign Policy and Detente." Paper read at Institute for World Affairs, San Diego, California, 27-30 June 1976.

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PAONE, Rocco M., Professor, "Naval Technology in Foreign Environmental Programs." Paper read at Panel of International Studies Association, St. Louis, Missouri, 17-21 March 1977.

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RAU, Robert L., Associate Professor, "A Survey of Singapore's Relations with Indonesia and Malaysia, 1965-1976." Paper read at the 30th International Congress of Orientalists, Mexico City, 3-8 August 1976.

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TOMLINSON, Rodney G., Assistant Professor, "The Application of Catastrophe Theory to the Study of International Event Flows." Paper read at the intensive panel on Catastrophe Theory at the Annual Meeting of the International Studies Association at St. Louis, Missouri, 16-20 March 1977.

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TOMLINSON, Rodney G., Assistant Professor, "Modeling the International Event Stream -- The USA and China." Paper read at the annual meeting of the International Studies Association (West), University of Southern California, Los Angeles, California, 21-24 April 1977.

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TOMLINSON, Rodney G., Assistant Professor, "Identifying Change in International Political Behavior." Paper read at Washington-Annapolis-Baltimore Area Symposium on Computers in Education, May 1977.

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**OTHER ACTIVITIES**



## NIMITZ LIBRARY

### PUBLICATIONS

### NIMITZ LIBRARY

SKALLERUP, Harry R., Associate Professor, "HMS TEES: From 6th Rate Warship to Floating Church," Nautical Research Journal, 22(December 1976), 163-167.

This article describes how the 28-gun British ship Tees, built in 1817, was, after her hulking in 1826, converted into a floating chapel known as The Episcopal Mariners' Church. The younger William Scoresby, F.R.S., master mariner, arctic explorer-scholar-writer, and clergyman, was her first chaplain. Prayerbooks were furnished by the liberality of the Liverpool Christian Knowledge Society.

The floating church at Liverpool was thought to be a success by its originators, especially at the inception of the operation. An average attendance of about 800 persons (mostly sailors) at weekly divine services was claimed by its governing committee for the first half-year. The Tees was sold on June 28, 1872 at Liverpool, which presumably was the end of the hulk.

The article contains drawings of the Tees before and after alteration into a church.

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## PHYSICAL EDUCATION DEPARTMENT

### SPONSORED RESEARCH

### PHYSICAL EDUCATION DEPARTMENT

#### DESIGN OF AN EFFECTIVE TRAINING PROGRAM FOR MILITARY WOMEN, TO INCREASE CARDIOVASCULAR ENDURANCE AND MUSCULAR STRENGTH

Researcher: Associate Professor Heinz W. Lenz

Sponsor: Naval Academy Research Council

In October 1975 the President signed a bill which directed that women be admitted to the Service Academies of the United States. It is stipulated in this law that Service Academies' requirements, for women, "shall be the same as those required for male individuals". However, there is additional direction that minimum adjustments be carried out as required due to physiological differences between the sexes. This aspect of the law had implications for the physical fitness training programs. The academies were concerned with two specific questions: What are the physiological differences between men and women? What are the needed minimum adjustments in performance between men and women? The literature reveals physiological differences satisfactorily; however, it remained for independent research on part of all three academies to determine the range and nature of stipulated adjustments. Since the summer of 1976 three fitness programs have been in existence at the three major service academies. In 1977 it appeared timely to investigate the existing programs.

The purpose of this research project is to design, for women, an improved training programs to increase cardiovascular endurance and muscular strength. Primarily, this study focuses on freshmen women at the three major service academies. However, in view of the fact that these women are in many respects similar to freshmen women throughout the United States, conclusions may be of value to the field of women's physical education.

To date three of the major service academies have been visited, as well as the Merchant Marine Academy, Kings Point, New York. Training, to increase levels of physical fitness, is scheduled throughout the initial summer training period, at the three major service academies. The following data have been gathered:

1. Results of all academy candidates in the Physical Aptitude Examination. This information is to serve as a common base line because the PAE is precisely the same for the three academies.
2. All three physical fitness programs have been analyzed. Duration, frequency and intensity will be recorded. The life styles of midshipmen and cadets, throughout the summer training period, has been recorded in calories offered for a 24-hour period, hours slept, changes in weights, number of days missed as a result of injuries, types of shoes worn and intensity of training not primarily of physical nature.

3. Results of fitness tests administered to women throughout the academic year 1976-1977, in running tests and muscular strength have been recorded.

Until all gathered data is examined statistically, it is possible to make only preliminary observations. At this date it appears that vast differences exist in fitness training methods at the three academies. Examining data for the Naval Academy, the Military, and the Air Force Academy, it is established that summer training is respectively 65 days, 54 days, and 42 days; hours of sleep, 6 hours, 8 hours, and 7 hours; calories offered throughout a 24-hour period are respectively 4,400 calories, 4,500 calories, and 6,000 calories. A preliminary examination of the results of the achievements on physical fitness tests indicates that there appears to be a significant difference. However, this hypothesis must be examined statistically.

The project is being continued throughout this fiscal year. The data gathered will be statistically examined. An analysis of covariance is to be carried out. The statistical work of this project is carried out under the guidance of the Associate Director for Educational Development, of the Naval Academy's Computer Center. When the gathered data can be examined and after life-styles of midshipmen and cadets have been completely surveyed, it will be possible to determine strengths and weaknesses of the existing programs. Then, it will be possible to design a model physical fitness program to improve cardiovascular endurance and muscular strength.

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